THE

GEOLOGICAL MAGAZINE.

NEW SERIES. DECADE IV. VOL. VI.

No. V.—MAY, 1899.

ORIGINAL ARTICLES.

I.—Note on a New Australian *Pterygotus*.

By Professor Sir Frederick McCoy, K.C.M.G., M.A., D.Sc. (Cantab), F.R.S.

I AM greatly indebted to Mr. F. Spry for bringing to my knowledge some extremely interesting Upper Silurian fossils collected by him with great care and diligence from the tunnels excavated through the rocks underlying Melbourne during the progress of the new great drainage works for the city, carried out by the Metropolitan Board of Works. The age of the strata containing these fossils was originally determined by me for Selwyn's Geological Survey Maps of Victoria.

Four of these fossils belong to genera hitherto unknown in the Victorian rocks, and belong to groups of special interest. I subjoin preliminary descriptions of one of these, that credit may be secured to Mr. Spry for his scientific zeal in doing such good service to geology while carrying out his professional duties.

Pterygotus Australis (McCoy). Upper Silurian: Melbourne.

This is represented by about half of a somatic segment of a species most nearly resembling the *Pterygotus bilobus* (Salter) of the black flaggy uppermost Silurian rock of Lesmahago, which the matrix of this specimen, from the main sewer tunnel in Domain Road, South Yarra, almost exactly resembles. The anterior margin is slightly

convex to the front (as usual), slightly thickened, and the anterior covered border smooth and concave (preserved for about three lines in antero-posterior length). The dorsal surface, from the anterior margin to about ten lines back, is covered with the characteristic scale-like markings of the genus, composed as usual of semi-oval, narrow, prominent ridges, the wide open part of the curve directed forwards and the convexity backwards, averaging about ten in longitudinal and about seven in transverse direction in six lines, and rather more regularly equal than in *P. bilobus*. The entire antero-posterior length of the segment is 2 inches 5 lines, the posterior portion, of about 1 inch 9 lines, as usual in the genus, being free of scale-like sculpturing. The entire breadth of segment I estimate would have been about 6½ inches.

None of the Merostomatous Crustacea have been found before in this country, and Mr. Spry has presented the type-specimen to the National Museum.

II. — On the Occurrence of Allanite in the Hornblende-Granite of Lairg, Sutherlandshire.

By Lieut.-General C. A. McMahon, F.R.S.

In the September number of the Geological Magazine for 1898, Mr. J. S. Flett, B.Sc., describes, at p. 388, the occurrence of Allanite in the granite of Fell Hill, Cree Town, Kirkcudbrightshire, and in a biotite gneiss in Sunday, one of the Orkney Islands.

I have recently been re-examining a slice taken from a sample of Heddle's 'Syenite' collected by me at Lairg, Sutherlandshire, some years ago, and I find it contains a very good crystal of allanite.

The rock is a hornblende-granite, and the slice, when examined under the microscope, is found to contain the following minerals; namely, orthoclase, plagioclase, quartz, biotite, hornblende, sphene, apatite, zircon, chlorite, and allanite.

The sphene is rather abundant and is idiomorphic in characteristic forms. The chlorite is the product of the alteration of biotite.

The allanite is in a lath-shaped, badly terminated, crystal, which extinguishes, and has the major (+) axis, at 36° to the line of elongation. The slice is therefore one parallel to the clinapinacoid. It is of pale orange-yellow colour in transmitted light (my slice is a very thin one), and is distinctly but feebly pleochroic. When revolved between crossed nicols it shows, prior to extinction, a decided zonal structure, which cannot be seen in ordinary transmitted light. The crystal is traversed by irregular cracks, more or less transverse to the direction of elongation; but no regular cleavage is to be seen.

Good-sized crystals of allanite appear to be rare; but crystals and grains of microscopic size are numerous in the rock, and I succeeded in isolating many of them. The mineral in the Lairg granite is brown-red in reflected light, and when the rock is pounded up its peculiar colour marks it off from the other minerals and enables the petrologist to pick it out from them with the aid of

a good pocket lens. The mineral possesses considerable lustre, and bright facets catch the light and facilitate its isolation. Crystalline faces are numerous and often suggest those shown at fig. 4, p. 522 of Dana's "System of Mineralogy," 6th edition. The fracture of the mineral is subconchoidal.

The specific gravity of the Lairg mineral is over 3·32, and consequently it sinks readily in methylene iodide. It would be difficult to ascertain the exact specific gravity of the Lairg mineral, as, owing to the microscopic size of the fragments, heavy liquids of viscous character—as, for instance, cadmium borotungstate above a certain density—are of no use.

The refraction of the mineral is also high, being well over 1·740 that of methylene iodide. On the other hand its double refraction is weak, exhibiting no colour higher than a decidedly dull yellow of the 1st order of Newton's scale.

The pleochroism of the Lairg mineral is usually distinct and occasionally strong, the change of colour being from a brown-red, or red-brown, to a brown-yellow. Sometimes, but rarely, there is a suspicion of green in the brown.

As regards the optical character of the crystals the Lairg specimens are positive. I have been able to observe the interference figure in convergent polarized light in many of the isolated fragments, and its sign is uniformly positive. Dana, in his "System of Mineralogy," 6th edition, 1892, says that allanite is optically negative; but Michel Lévy, in his "Les Minéraux des Roches," gives the sign as $\pm$. The Lairg specimens therefore support Michel Lévy's view.

Mr. J. J. Harris Teall, F.R.S., has very kindly allowed me to examine thin slices of another Scotch granite, that of Hildesay, in his private collection, in which a precisely similar mineral to that in the Lairg rock occurs, which he had previously suspected to be allanite. The mineral in these two rocks are clearly identical, and the description of one would do for the other. Extinction in one of Mr. Teall's crystals is nearly straight, showing elongation approximately parallel to the orthopinacoid, but in other crystals it varies, being generally about 34°. One of the crystals shows the zonal structure well.

In the Hildesay granite the allanite is associated with much epidote, but this mineral does not appear to be present in the Lairg rock. My slice contains none, and I have not observed any among the crushed fragments.

The allanite of the Lairg hornblende-granite appears to be an original constituent; it is corroded by the quartz of the groundmass, and it encloses numerous micro-crystals which appear to represent two mineral species; but they are too minute for exact determination.

The Lairg mineral fuses easily in the flame of a Bunsen burner, but is very slightly attacked by hydrochloric or by nitric acids. When ground to a fine powder it yields on prolonged heating to *aqua regia*.

On all the points noted above, the Lairg mineral agrees with allanite; and as I know of no other mineral which, on all points,

fits the above evidence, I do not see room for doubt regarding its identification.

In the future, varieties of allanite will no doubt be distinguished from one another, the varieties being dependent on the proportion of the rare metals, and also on the proportion of manganese present in them; but the accurate determination of them will be no easy matter. The collection of material, for instance, from the Lairg rock, is a work of labour; and when obtained, the microscopic fragments are found under high powers to be stuffed full of endo-minerals.

III.—Glaciated Valleys in the Cuillins, Skye.

By Alfred Harker, M.A., F.G.S., of H.M. Geological Survey of Scotland.
(Communicated by permission of the Director-General.)

MANY geologists have recognized that valleys, which have once been occupied by large glaciers, exhibit peculiarities which can only be ascribed to glacial erosion modifying the earlier water-worn form of the land-surface. Indeed, anyone who allows ice-action to be locally a factor of importance in erosion, must expect that the resulting topographical forms will differ in some measure from those proper to water-erosion. Not only does ice, in virtue of its physical properties, obey different laws as regards pressure and flow, but, what is of equal importance, it fills the whole valley instead of following certain narrow channels. We may hope that, just as Gilbert and others have worked out the principles of water-erosion, so the much more difficult problem of ice-erosion may some day be reduced to analysis. An attempt in this direction has been made by McGee in a paper on "Glacial Cañons,"[1] which, however, I cite here rather for its brief summary of the observed characteristics of glaciated valleys.

The object of the present note is merely to draw attention to a district in which these characteristics are exhibited in their most typical form. This is due to two facts. Firstly, the mountain-group of the Cuillins is wholly carved out from a single rock (gabbro), so that all complication arising from the juxtaposition of harder and softer materials is eliminated. Secondly, there are none of the difficulties which attach to a district once overridden by foreign ice. The glaciation of the Cuillins was entirely local, and, although the ice passed over some of the lower watersheds, the flow in the main valleys was always in the natural direction. Further, the topographical forms are not only of a simple order, but are also very clearly exposed. In the mountain tract the drift is never thick enough to obscure the shape of the ground, and the higher valleys, like the mountains themselves, show nothing but naked rock. Since the erosion under existing conditions is a negligeable quantity, we have the forms of the valleys displayed practically as they were left by the ice.

The chief characteristics of the valleys in the Cuillins are summarily as follows. It is important to notice that, while some of them (e g. rock-basins) belong to glacial erosion only, others consist

[1] Journal of Geology, vol. ii (1894), pp. 350-364.

in the exaggeration of features which may be found in some degree in non-glaciated valleys. These are therefore not capable of precise formulation without some kind of quantitative expression, but they are very conspicuous on the ground, and come out clearly in profile sections drawn to true scale.

(i) The valleys always tend in cross-section to the U rather than the V form.

(ii) This tendency is most marked in the upper parts of the valleys (Fig. 1).

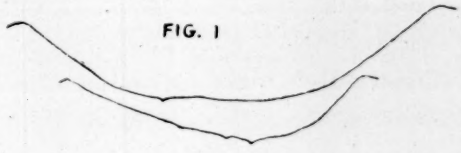


Fig. 1.—Two transverse sections across the upper and lower portions of Coir' a' Ghreadaidh respectively, viz., from the summit of Sgùrr Thuilm to that of Sgùrr na Banachdich, and from the western end of the Thuilm ridge to An Diallaid.

(iii) The head of a valley is usually expanded into a circular amphitheatre. This is the typical 'corrie' (equivalent to 'cwm' and 'cirque'), though this term is currently applied to a valley of almost any form.

(iv) In the centre of such amphitheatre there may be a shallow circular rock-basin occupied by a mountain-tarn.

(v) In one case (Coruisk) there is a deeper and more elongated rock-basin in the lower and narrower part of the valley. Loch Coruisk is a little over a mile in length, and less than one-sixth of a mile in width. The surface is 26 feet above O.D. and the rocky bottom of the stream at the outlet only a few inches lower. The greatest depth sounded[1] is 96 feet, which occurs somewhat nearer to

Fig. 2.—Longitudinal section down the valley made up of Lota and Harta Corries, beginning at Bealach an Bhasteir.

the head than to the foot of the lake and only about 80 yards from the north-east shore, from which the hills rise steeply (Fig. 3). Rocky islets occur near the middle and near the foot of the lake.

[1] The soundings were taken by members of the Scottish Mountaineering Club, and are marked on the reduced Ordnance Map accompanying No. 25 of the S.M.C. Journal, January, 1898.

(vi) In longitudinal profile the floor of a valley often consists of two or three stretches of relatively gentle slope separated by precipitous drops (Fig. 2). These features are not related to anything in the geological structure of the ground, and the levels are not the same in adjacent valleys.

(vii) A tributary valley debouches at a considerably higher level than the floor of the main valley, so that it terminates in a precipitous drop. This is true not only of the smaller tributary valleys but also of glens of considerable size (e.g. Tairneilear at its junction with Coir' a' Mhadaidh). The point sometimes comes out more clearly if we regard the lines of ice-drainage instead of the present watercourses. Thus the stream from Garbh-choire, the lower part of which is shown in Fig. 3, turns eastward to fall into the sea in

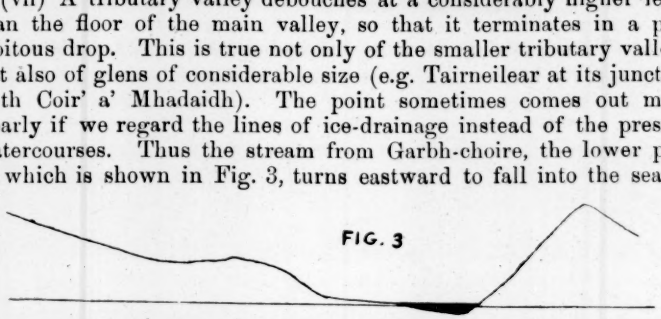


FIG. 3.—Section down the lower part of Garbh-choire and across Loch Coruisk at its deepest part.

Loch Scavaig, but in one stage of the glaciation the ice-drainage was partly over the low watershed into Coruisk.

Other features might be enumerated, but they appear to arise merely from the co-operation of the several conditions implied in the preceding paragraphs. Thus we find circular amphitheatres enclosed by steep slopes and isolated by precipitous drops from the valleys into which they drain. Where such a corrie occurs at the head of an important valley (e.g. Coir' a' Ghrundda), it falls under the heads (iii) and (vi). Where it overlooks the side of a main valley (e.g. Coir' an Lochain, Fig. 4), it falls under (iii) and (vii).

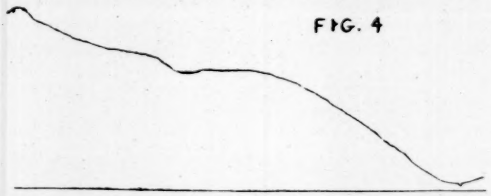
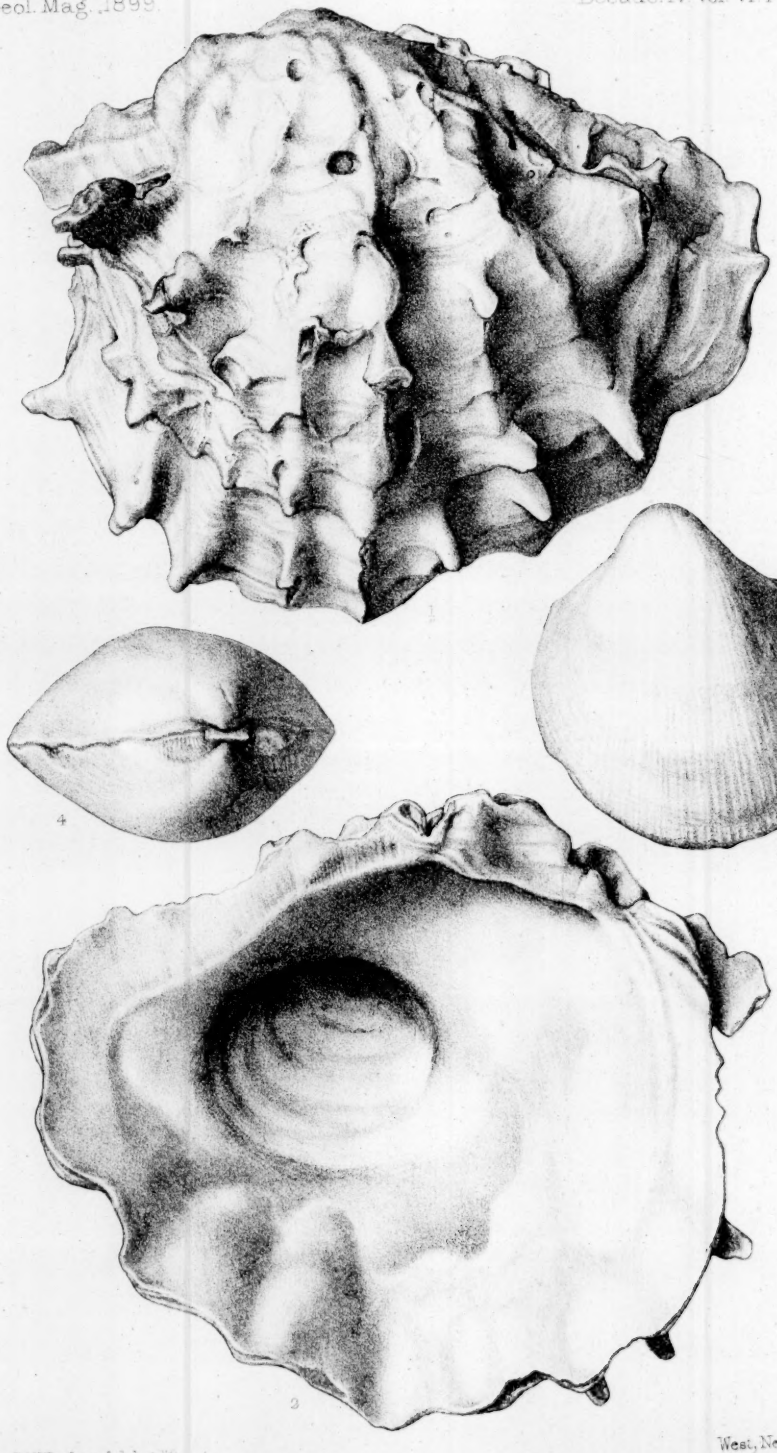


FIG. 4.—Section down Coir' an Lochain (from the Bealach from Coir' a' Ghrundda) through the tarn and down to the Coruisk valley.

In like manner other scenic features of the district are found to resolve themselves into the elementary forms already set forth above, and these seem therefore to embody all that is characteristic of a glaciated valley-system in its simplest development. If so, they afford at the same time the tests by which any synthetic theory of the mechanics of ice-erosion must be tried, but such theory is, as has been remarked, still a desideratum. McGee's treatment of the problem, referred to above, labours under the drawback that it too



G.M.Woodward del. et lith.

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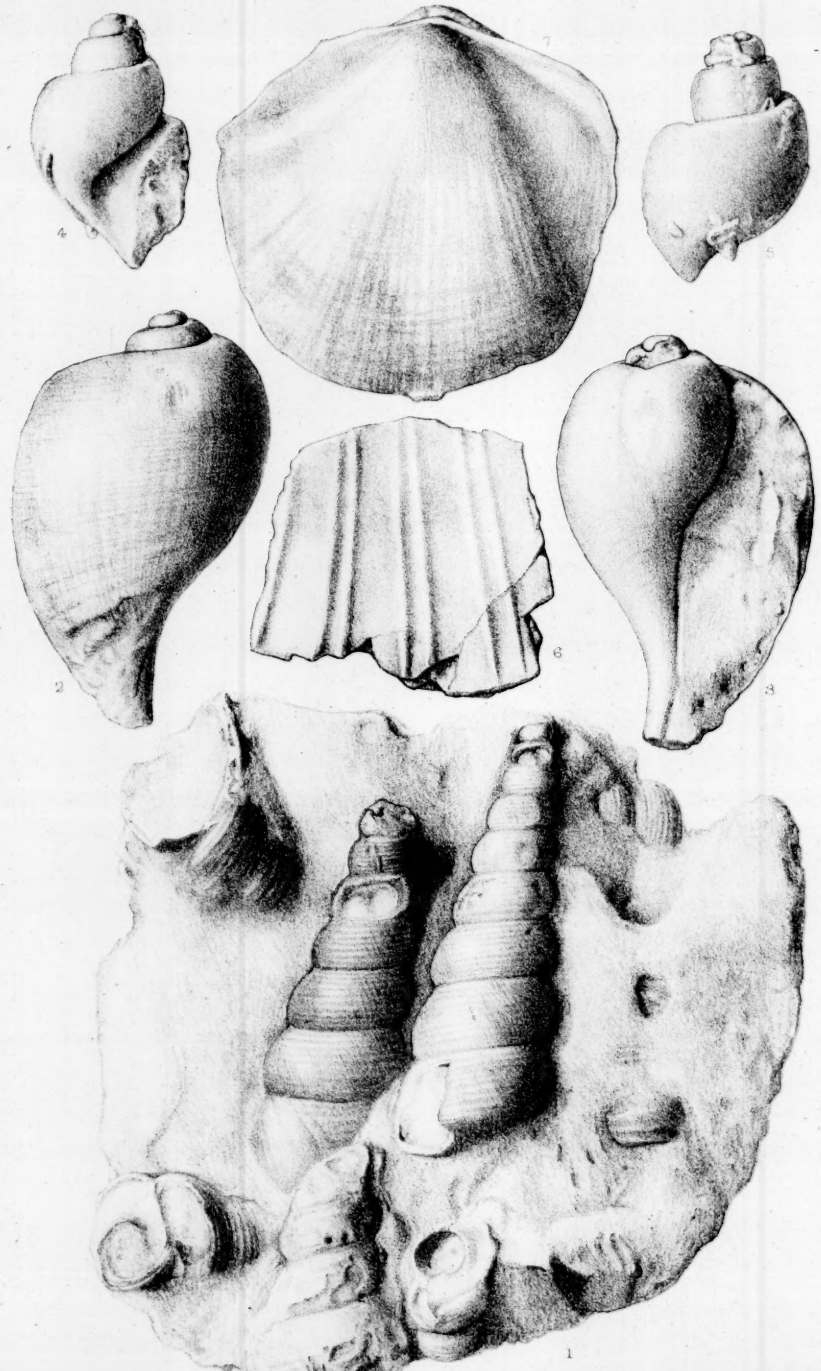
Egyptian Miocene Shells.



G.M.Woodward del. et lith. West, Newman imp.

Egyptian Miocene Shells.

often involves conflicting elements, the relative value of which is a matter of uncertainty.

The figures given in illustration of the above observations are profile sections drawn very roughly to true scale (two inches to a mile). Where a section is drawn longitudinally down a valley, it is not always taken along a straight line, but is made to follow the more important bends of the valley. The horizontal line in each figure represents the sea-level (O.D.).

IV.—Notes on some Marine Miocene Shells from Egypt.

By R. Bullen Newton, F.G.S.

(PLATES VIII and IX.)

THE marine Miocene shells from Egypt referred to in this paper form part of the collection of Egyptian fossils sent to the British Museum for determination by Captain H. G. Lyons, R.E., F.G.S., Director-General of the Geological Survey of Egypt.

Several writers have contributed lists of marine molluscan species occurring in the different Miocene areas of Egypt—the Siwa Oasis, the Pyramids, Jebel Geneffe, Chalouff, and the coast of the Bitter Lake—among whom may be mentioned, A. B. Orlebar,[1] Oscar Fraas,[2] Ch. Laurent,[3] Gerhard Rohlfs,[4] L. Lartet,[5] and Mayer-Eymar,[6] but for the most complete treatise on this subject we are indebted to Dr. Theodor Fuchs,[7] whose principal investigations were published in the *Palæontographica* for 1883.

Dr. Fuchs' interesting comparisons between the marine Miocene shells of Egypt and those of the Vienna Basin enabled him to establish the fact that a large number of the species were common to both areas; a result more particularly noticeable when comparing the "Grunden Schichten" (=Helvetian) forms with those of the Siwa Oasis, although certain other species were regarded as analogous to those found in the "Horner Schichten" (=Oligocene—Aquitanian stage) and "Steinabrunner Schichten" (=Miocene—Tortonian stage) of the same Basin. The present collection appears to contain representatives of the three lower stages of the Miocene system, no true characteristic Oligocene forms having been determined, viz.:—

Miocene { Tortonian. / Helvetian. / Burdigalian (=Langhian).

[1] "Some Observations on the Geology of the Egyptian Desert": Journ. Bombay Branch Roy. Asiatic Soc., 1846, No. x, pp. 229–250; 14 plates of fossils.

[2] "Aus dem Orient: Geologische Beobachtungen am Nil, auf der Sinai-Halbinsel, und in Syrien," 1867, pp. 157–173.

[3] "Essai Géol. sur les terrains de l'Isthme Suez": Annuaire Soc. anciens élèves Écoles, Arts, Métiers, 1870, p. 230.

[4] "Von Tripolis nach Alexandrien," 1871, vol. ii. pl. iv.

[5] "Essai Géol. Palestine, l'Egypte, et l'Arabie," pt. ii, Paléontologie: Biblioth. Hautes Etudes Sci. Nat., vol. vii (1873), No. 2, pp. 48, 73.

[6] "Zur Geologie Egyptens": Viert. Nat. Ges. Zürich, vol. xxxi (1886), pp. 263–5.

[7] "Die Geologische Beschaffenheit der Landenge von Suez": Denk. Akad. Wiss. Wien., vol. xxxviii (1878), pt. 2, pp. 36–8. In Zittel's memoir, "Ueber den Geologischen Bau der libyschen Wüste," 1880, pp. 41–5. "Beiträge Kenntniss Miocaenfauna Aegyptens und der libyschen Wüste" (in Zittel's work on Egypt): Palæontographica, vol. xxx (1883), pp. 19–66 (or pp. 1–48), pls. vi–xiii (i–viii) and xix–xxii (xiv–xvii).

It remains to be stated that the majority of the specimens in this collection were obtained from various places comprised in a tract of country lying between Cairo and Suez, which are referred to as 'Camps,' each one being numbered and having the following geographical position :—

Camps.	Latitude.	Longitude.
No. 6	29° 57′ 40″ N. ...	31° 44′ 30″ E.
No. 9	30° 10′ 15″ ...	31° 45′ 20″
No. 19	30° 16′ 30″ ...	31° 54′ 40″
No. 21	30° 8′ 40″ ...	31° 56′ 40″
No. 22	30° 15′ 30″ ...	32° 2′ 10″

The additional localities recorded for two of the species are: W. of Jebel Zait, off the Gulf of Suez, and Jebel Geneffe, near Suez.

MOLLUSCA : GASTEROPODA.

Genus TUGURIUM, P. Fischer.

Kiener & Fischer: Spécies Coquilles Vivantes (*Calcar*, *Trochus*, etc.), 1880, p. 450; Fischer's Manuel Conchyliologie, 1885, p. 760.

Type.—*Trochus Indicus*, Gmelin.

TUGURIUM BORSONI, Sismonda, sp.

Phorus gigas, Michelotti: Desc. Foss. Miocènes Italie, Sept., 1847, p. 175, pl. vii, fig. 1 (non *Trochus gigas*, Borson, 1821).

Phorus Borsoni, Sismonda (Bellardi MS.): Synopsis Pedemontii Fossilium, 2nd ed. (1847), p. 50.

Tugurium Borsoni, var. *pagodæformis*, Sacco: Moll. Terz. Piemonte, 1896, pt. xx, p. 27, pl. iv, figs. 4, 5.

Description.—*Testa conica, libera, umbilicata; anfractibus planis, infundibuliformibus, basi repanda; periphæria rotundata; umbilico parvo; apertura trigona.* (Michelotti.)

Dimensions.—Height, (about) 40 millimètres; diameter of base, 40 millimètres.

Some conical limestone casts contained in this collection appear to be referable to this species. They possess about five or six wide, depressed whorls, deeply sutured, of infundibuliform arrangement, and obtusely acute at the periphery; the base is concave and prominently umbilicated; surface exhibiting no sculpture. One of the specimens has some foreign material (small bivalve shells) agglutinated to the spire in the neighbourhood of the suture. This character, together with its perforated base, would indicate its relationship to Fischer's *Tugurium*, in which genus it is here placed. From a comparison of the published figures of this species, especially those last issued by Sacco, there is little doubt that these Egyptian casts may be safely referred to the Italian species which characterizes the Helvetian division of the Miocene of that country. The *Trochus gigas* of Borson, at one time confused with this species, belongs to *Pleurotomaria*.

Horizon.—Miocene (Helvetian).

Distribution.—North Italy; Egypt, between Camps 19 and 22. Coll. Geol. Surv. Egypt, No. 815, Box No. 4c.

Genus TURRITELLA, Lamarck.

Mém. Soc. Hist. Nat. Paris, 1799, p. 74.

TYPE.—*Turbo terebra*, Linnæus.

TURRITELLA TEREBRALIS, Lamarck. (Pl. VIII, Fig. 1.)

Turritella terebralis, Lamarck: Hist. Nat. Anim. sans Vert., vol. vii (1822), p. 59. Basterot, "Desc. Tert. Sud-Ouest France": Mém. Soc. Hist. Nat. Paris, vol. ii (1825), pt. i, p. 28, pl. i, fig. 14. Lartet, "Essai Géol. Palestine, l'E'gypte, et l'Arabie." pt. ii, Paléontologie: Biblioth. Hautes E'tudes Sci. Nat., vol. vii (1873), No. 2, p. 48. Sacco: Moll. Terz. Piemonte, 1895, pt. xix, p. 8.

DESCRIPTION.—*Testa elongato-turrita, transversim striata; striis confertis æqualibus; anfractibus medio convexis, basi apiceque depressis; suturis infra marginatis.* (Lamarck.)

REMARKS.—As far as detail is concerned the Egyptian examples of this shell are well preserved, although none of them are quite perfect. The main characters of the species as given originally by Lamarck include its elongate, turreted form, the basal and apical depression of the nearly centrally inflated whorls, the regular, elevated spiral striæ forming its sculpture, with no evidence of longitudinal striations, and the possession of a prominent suture. The basal margin of each whorl extends obliquely to the suture. The spiral angle of 13° agrees with the type figured by Basterot from the neighbourhood of Bordeaux.

HORIZON.—Miocene (Helvetian).

DISTRIBUTION.—Bordeaux; N. Italy. Egypt: Jebel Geneffe (Lartet); Camp 22 (= 23*a*); Jebel Geneffe, Suez Canal (5*c*). Coll. Geol. Surv. Egypt, No. 328, Box No. 23*a*; No. 990, Box No. 5*c*.

Genus STROMBUS, Linnæus.

Systema Naturæ, 10th ed. (1758), p. 742.

TYPE.—*S. pugilis*, Linnæus.

STROMBUS NODOSUS, Borson, sp.

Mitra nodosa, Borson, "Saggio Orittog. Piemontese": Mem. R. Ac. Sci. Torino, vol. xxv (1820), p. 208, pl. i, fig. 9.

Strombus Bonelli, Brongniart: Mém. Terr. Calc.-Trapp. Vicentin, 1823, p. 74, pl. vi, fig. 6. Hoernes, "Foss. Moll. Tert.-Beck. Wien": Abhandl. k. k. Geol. Reichs., vol. iii (1852), p. 189, pl. xvii, figs. 2–6.

Strombus, sp. (cf. *Bonelli*), Fuchs: Palæontographica, vol. xxx (1883), p. 36 (18), pl. vi (i), fig. 4.

Strombus nodosus, Sacco: Moll. Terz. Piemonte, 1893, pt. xiv, p. 4.

DESCRIPTION.—Species having an elongate, narrow, oblong, subcylindrical test, ornamented with transverse sulcations; whorls convex, divided by a deep suture and bearing nodular plications in the centre; last whorl with a ring of large prominent tubercles in the upper part, beneath being (in old forms) some minor tubercles separated by spiral sulcations; aperture elongate, subequal; labrum thick and smooth within; base curved in adult forms; canal very short; columella smooth.

DIMENSIONS (of medium-sized specimen).—Length, (about) 50 mm.; diameter, 30 mm.

REMARKS.—The specimens referred to this species are limestone casts, but possessing certain definite characters which suffice for their determination. Both young and adult examples are represented. The narrow, elongate form, its long and deeply

sutured spire, with the centrally nodular plications, as well as the spiral striæ, or sulci, ornamenting the surface, serve to distinguish it from *S. coronatus*, Defrance, a closely related species. *S. coronatus* is a shorter and much wider shell with a sharp conical spire, consisting of depressed whorls feebly sutured. Fuchs has figured a similar cast from Egypt under the name of *Strombus* cf. *Bonelli*, but the present examples exhibit rather more clearly the sculpture of the species. Hoernes and Sacco must be referred to for a longer synonymy of this species than is offered here; it is important to notice that Sacco has united *S. Bonelli* of Brongniart, which is an adult form, with the present species.

Horizon.—Miocene (Helvetian).

Distribution.—North Italy; Bordeaux; Vienna Basin; Switzerland, etc. Egypt: Oasis Siwa (Fuchs); between Camps 19 and 22. Coll. Geol. Surv. Egypt, No. 833, Box No. 3*c*.

Genus PYRULA, Lamarck.

Mém. Soc. Hist. Nat. Paris, 1799, p. 73.

Type.—*Bulla ficus*, Linnæus. (Syn. *Ficula*, Swainson.)

PYRULA CONDITA, Brongniart. (Pl. VIII, Figs. 2, 3.)

Pyrula condita, Brongniart: Mém. Terr. Calc.-Trapp. Vicentin, 1823, p. 75, pl. vi, fig. 4. Sowerby (G. B.): Quart. Journ. Geol. Soc., vol. iii (1847), p. 415. Hoernes, "Foss. Moll. Tert.-Beck. Wien": Abhandl. k. k. Geol. Reichs., vol. iii (1853), p. 270, pl. xxviii, figs. 4–6.

Ficula condita, Sacco: Moll. Terz. Piemonte, etc., 1891, pt. viii, p. 23, pl. i, fig. 27.

Description.—*Testa ficoidea, cancellata; striis transversis erectiusculis; interstitiis longitudinalibus, frequentibus, decussantibus; spira brevissima, plano-retusa, ventro mucronata; apertura oblonga.* (Hoernes.)

The diagnosis of this species, given here, is that taken from Hoernes' work, which, on account of being somewhat fuller, is thought to be of more practical use than the original as drawn up by Brongniart.

Remarks.—Several casts in the collection evidently belong to this species. They exhibit the smooth arcuate columella, an oblong fusoid aperture, a depressed spire, and an elongate terminal area. The ornamentation, although obscure, is seen to consist of a cancellated structure made up of close longitudinal striations crossed by strong, elevated spiral ridges with finer striæ between each. These specimens have been compared with some beautiful examples of the species in the British Museum from Saucats, S.W. of France, and are found to agree in all essential details.

The species differs from *P. reticulata* of Lamarck in possessing a more delicately arched columella and in its finely cancellate sculpture. The specimen numbered 58*a* appears to be a very old form of this species.

Dimensions.—Length, 55 mm.; width, 35 mm.

Horizon.—Miocene (Helvetian).

Distribution.—Turin; S.W. France; Vienna Basin; Portugal (Sowerby), etc. Egypt: between Camps 19 and 22 (1*c*), and

Camp 22 (58*a*). Coll. Geol. Surv. Egypt, No. 816, Box No. 1*c*; No. 326, Box No. 58*a*.

Genus DELPHINULA, Lamarck.

Annales Muséum Paris, vol. iv (1804), p. 108.

Type.—*Turbo delphinus*, Linnæus.

(?) DELPHINULA, sp.

Remarks.—The two specimens referred doubtfully to this genus have very convex whorls and a slit-like perforation at the base of the columella; the aperture is large, oval, and acuminate anteriorly; no sculpture can be traced, and no further identification of the specimens is possible.

Dimensions.—Height, (about) 50 mm.; diameter, 45 mm.

Horizon.—Miocene (Helvetian).

Distribution.—Egypt: between Camps 19 and 22. Coll. Geol. Surv. Egypt, No. 817, Box No. 46*c*.

Genus CANCELLARIA, Lamarck.

Mém. Soc. Hist. Nat. Paris, 1799, p. 71.

Type.—*Voluta reticulata*, Linnæus.

CANCELLARIA, sp. (Pl. VIII, Figs. 4, 5.)

Remarks.—Two limestone casts appear to belong to this genus. They have convex whorls, an elongate turreted spire, a subcanaliculation at the base, and an oval aperture pointed anteriorly. In this last character and their form generally they are doubtless related to *C. acutangula* of Faujas-de-Saint-Fond, a species common to the Miocene beds of Bordeaux, N. Italy, Corsica, etc.

Dimensions.—Length, 34 mm.; diameter, 22 mm.

Horizon.—Miocene (Helvetian).

Distribution.—Egypt: between Camps 19 and 22. Coll. Geol. Surv. Egypt, No. 833, Box No. 3^{x} *c*.

MOLLUSCA: LAMELLIBRANCHIATA.

Genus OSTREA, Linnæus.

Systema Naturæ, 10th ed. (1758), p. 696.

Type.—*O. edulis*, Linnæus.

OSTREA DIGITATA, Eichw., var. ROHLFSI, Fuchs.

Ostrea digitata, Eichwald: Natur. Skizze Lithauen Volhynien und Podolien, 1830, p. 213.

Ostrea digitalina, Du Bois de Montpéreux: Conchiologie Foss. Wolhyni-Podolien, 1831, p. 74, pl. viii, figs. 13, 14.

Ostracit, Rohlfs: Von Tripolis nach Alexandrien, vol. ii (1871), pl. iv, fig. 1 (no text).

Ostrea Rohlfsi, T. Fuchs: Denk. Akad. Wiss. (Wien), vol. xli (1879), p. 106, pl. vi, figs. 5–8.

Ostrea digitalina, var. *Rohlfsi*, T. Fuchs: Palæontographica, vol. xxx (1883), pp. 44 (26), 55 (37), 61 (43); pl. xii (vii), figs. 3–6; pl. xxii (xvii), figs. 1–3.

? *Ostrea digitalina*, Mayer-Eymar: ibid., p. 74 (8).

Remarks.—Although belonging to the group of oysters characterized by *O. digitata* of Eichwald (misspelt *O. digitalina* by most authors), this form exhibits some differences, especially in sculpture, which require the adoption of the composite determination introduced by Fuchs, as *O. digitata*, var. *Rohlfsi*. Probably a new name would have been preferable for the Egyptian shell, for, while agreeing with

the European (Russia, Poland, etc.) species in its elongate shape and somewhat acute ligamental region, it differs in the absence of true digitiform plications on the external surface of the lower or convex valve, this feature being replaced by a series of closely-set, radial, and lamellose costæ, typical of *O. Rohlfsi* from the Tertiaries of Persia. The Persian shell, however, has a much rounder outline and lacks any elongation of the dorsal margin.

The upper valves are depressed, and bear numerous concentric, sub-lamellose growth-lines; in the present collection some of these are covered in places externally with parasitic bryozoa belonging to the genus *Cellepora*.

Horizon.—Miocene (Tortonian).

Distribution.—Egypt: Siwa Oasis (Rohlfs and Fuchs); Jebel Geneffe, near Suez (Fuchs); island on the Lake of Birket-el-Qurum (Mayer-Eymar); Camp 21. Coll. Geol. Surv. Egypt, No. 627,[1] Box No. 27*a*,[1] and No. 361, Box No. 56*a*.

OSTREA GINGENSIS, Schlotheim, sp.

Ostréo-Pinnite, Knorr: Recueil Monumens Catastrophes Pétrifications, vol. ii (1768), pt 1, p. 119, pl. D.

Ostracites Gingensis, Schlotheim: Taschenbuch (Leonhard), vol. vii (1813), p. 72.

Ostrea crispata, Goldfuss: Petrefacta Germaniæ, vol. ii (1833), p. 15, pl. lxxvii, figs. 1*a*–*f*.

Ostrea Gingensis, Hoernes, "Foss. Moll. Tert.-Beck. Wien": Abhandl. k. k. geol. Reichs., vol. iv (1870), p. 452, pls. lxxvi–lxxx.

Ostrea? Gingensis, Sacco: Moll. Terz. Piemonte, etc., 1897, pt. xxiii, p. 10, pl. iii, fig. 29.

Description.—Shell with rather narrow, elongate valves; lower valve convex, concentrically and irregularly lamellose, longitudinally plicated, umbonal area slightly curved, triangular, more or less pointed and with a deep ligamental fossula; upper valve depressed, operculate, and ornamented with rugose, concentric, lamellar lines of growth.

Dimensions (of largest specimen).—Height, 120 mm.; length, 65 mm.

Remarks.—The Egyptian specimens of this species have very worn exteriors, the longitudinal plications being almost obliterated. Hoernes has given some excellent illustrations of the shell from the Vienna Basin, his largest example measuring 355 by 180 millimètres. This author's work must also be consulted for a fuller synonymy of the species than is here offered.

Horizon.—Miocene (Tortonian). In the manuscript lists Captain Lyons refers to these specimens as belonging to the Upper Miocene of Mayer-Eymar.

Distribution.—Vienna Basin; South Germany (Swabia); Switzerland; Bohemia; North Italy, etc. Egypt: west of Jebel Zait, western shore of the Gulf of Suez. Coll. Geol. Surv. Egypt, No. 622, Box No. 16*a*.

[1] Locality for these numbers is not recorded.

OSTREA FUCHSIANA,[1] sp. nov. (Pl. IX, Figs. 1, 2.)

DESCRIPTION.—Lower valve convex, rounded anteriorly, and produced in rear; summit truncate; surface divided up into a series of divergent plications, between each being a wide and conspicuous depression or channel; the plications at the different periods of growth becoming modified into hollow, narrow, and elevated spines. Near the posterior margin the interior of the valve exhibits a large, deep, and nearly round muscular scar with concentric markings; the ligamental area is small, triangular, and curved posteriorly; obscure marginal denticulations are present on each side of the shell near the ligamental area.

DIMENSIONS.—Height, 80 mm.; length, 100 mm.; diameter, 40 mm.

REMARKS.—The above characters are drawn up from a single lower valve which was found in association with *Ostrea vestita* and *O. Virleti*. Its very convex form and peculiar spiny character of the external surface appear to separate it from other species of *Ostrea*. It slightly resembles *O. foliosa*, Brocchi, from the Italian Pliocene, but in that species the outer surface is sulcated and fluted, and rarely shows elevated spines. The specimen, encrusted in places with a Celleporoid Bryozoa, is of fawn colour and entirely free from matrix. I have ventured to name this shell after Dr. Theodor Fuchs, one of the first authorities on the Miocene conchology of Egypt.

HORIZON.—Miocene (Tortonian).

DISTRIBUTION.—Egypt: Camp 19. Coll. Geol. Surv. Egypt, No. 342, Box No. 13^{c} *a*.

OSTREA VESTITA ?, Fuchs.

Ostrea vestita, Fuchs: Palæontographica, vol. xxx (1883), p. 44 (26), pls. xi (vi), xii (vii), figs. 1, 2.

REMARKS.—Among the Egyptian specimens are two lower valves of an oyster referred doubtfully to this species. They are of oval-oblong shape, very strong and thick, and apparently composed of regular foliaceous growths, the exposed edges of which do not, however, bear the fimbriated markings observable in Fuchs' figures of the type, though the absence of this character may be noted in his fig. 2 of pl. xii. In other details the specimens agree with *O. vestita*.

HORIZON.—Miocene (Tortonian).

DISTRIBUTION.—Egypt: Siwa (Fuchs); Camp 19. Coll. Geol. Surv. Egypt, No. 342, Box No. 13*a*.

OSTREA (ALECTRYONIA) VIRLETI, Deshayes.

Ostrea Virleti, *Ostrea pseudo-edulis*, *Ostrea excavata*, Deshayes: Expéd. Sci. Morée, vol. iii (1883), pt. 1 [Mollusques], pp. 122–4, pl. xxi, figs. 1–6.

Ostrea excavata, *Ostrea Virleti*, Abich, "Ueber Steinsalz, etc., Russischen Armenien": Mém. Ac. Imp. Sci. St. Pétersbourg, sér. VI, vol. ix (1859) (= pt. 1, vol. vii, Mém. Sci. Phys. Nat.), pp. 124–5, pl. ii, figs. 1, 2; pl. iii, fig. 1; pl. v, figs. 1, 2.

Ostrea Virleti, Fuchs: Denk. Akad. Wiss. (Wien), vol. xli (1879), pt. 2, p. 106, pl. iv, figs. 1–9; Palæontographica, vol. xxx (1883), pp. 43 (25), 61 (43), pls. ix (iv), x (v).

DESCRIPTION.—Shell of variable form, mostly orbicular or oblong; valves prominently plicated, margins more or less flexuous;

[1] *Non Ostrea Fuchsi* of A. de Gregorio, 1884.

plications elevated, few, squamose, irregularly radiate, and obsolete near ventral region in aged examples; ligamental fossula of lower valve moderately excavated and less perceptible in the upper valve.

Dimensions (of an adult valve).—Height, 135 mm.; length, 95 mm.; diameter, 50 mm.

Remarks.—Several of the present specimens are exceedingly thick and coarse, whilst the ligamental areas and muscular scars are of great size. Fuchs recognizes *O. pseudo-edulis* and *O. excavata* as synonymous with *O. Virleti*, the three species being somewhat difficult to separate from each other.

Horizon.—Miocene (Tortonian).

Distribution.—Morea (Deshayes); Russian Armenia (Abich); Persia (Fuchs). Egypt: Siwa and Jebel Geneffe (Fuchs); south of Middle Station, Old Suez Railway (24*a*); Camp 19 (13^{a}*a*); Camp 21 (12*a*). Coll. Geol. Surv. Egypt, No. 360, Box No. 12*a*; No. 342, Box No. 13^{a}*a*; No. 625, Box No. 24*a*.

Genus PECTEN, O. F. Müller.

Zool. Danicæ Prod., 1776, p. xxxi.

Type.—*Ostrea maxima*, Linnæus.

PECTEN ACUTICOSTATUS, G. B. Sowerby.

Pecten acuticostatus, G. B. Sowerby: Quart. Journ. Geol. Soc., vol. iii (1847), p. 49, pl. xvii, fig. 18.

Janira lævicostata, Seguenza, "Form. Tert. Reggio (Calabria)": Atti R. Ac. Lincei, ser. iii, vol. vi (1879), p. 188, pl. xiv, fig. 16.

Pecten acuticostatus, Fuchs: Palæontographica, vol. xxx (1883), p. 41 (23), pl. viii (iii), figs. 1–6.

Description.—*P. testa suborbiculari, valva altera convexa, costis radiantibus* 20, *acutis, elevatis; lateribus costarum interstitiisque concentrice striatis; auriculis magnis, tenuiter radiatim costatis.* (G. B. Sowerby.)

Remarks.—The above constitutes the original diagnosis of this species, which was drawn up from a fragmentary lower valve found in the Tertiary deposits of Portugal (Tagus district). An examination of the type in the Geological Society's Museum proves that some valves in the Egyptian collection can with safety be regarded as this species. A series of elevated triangular ribs, with wide interstitial spaces ornamented by fine concentric striæ, appear to distinguish the shell from other forms. Similar structures characterize *P. lævicostata* of Seguenza from Italian Pliocene (Zanclean) beds, and therefore it may be included as a synonym of Sowerby's older name.

Dimensions (of largest convex valve).—Height, 70 mm.; length, 75 mm.; diameter, 15 mm.

Horizon.—Miocene (Tortonian).

Distribution.—Tagus Beds of Portugal (Sowerby); Southern Italy (Seguenza). Egypt: Siwa and Geneffe (Fuchs); Camp 22 (26^{xxx}*a*) and probably from Camp 21 (20*a*). Coll. Geol. Surv. Egypt, No. 365, Box No. 20*a*; No. 324, Box No. 26^{xxx}*a*.

PECTEN ADUNCUS, Eichwald.

Pecten aduncus, Eichwald: Natur. Skizze Lithauen, Volkynien, und Podolien, 1830, p. 213.

Pecten Josslingi, G. B. Sowerby: Quart. Journ. Geol. Soc., vol. iii (1847), p. 419, pl. xvi, figs. 10–12.

Pecten convexo-costatus, Abich, "Ueber Steinsalz, etc., Russischen Armenien": Mém. Ac. Imp. Sci. St. Pétersbourg, sér. VI, vol. ix (1859), pt. 1, p. 118, pl. i, fig. 4.

Pecten aduncus, Hoernes, "Foss. Moll. Tert.-Beck. Wien": Abhandl. k. k. geol. Reichs., vol. iv (1867), p. 401, pl. lix, figs. 7–9. Fuchs: Palæontographica, vol. xxx (1883), p. 36 (54), pl. xix (xiv), figs. 1–5.

DESCRIPTION.—Species with very convex lower valve and a rounded, incurved umbone; costæ about 17, rounded, wide, smooth, and separated by conspicuous sulci, or grooves, which are ornamented with fine concentric striations; upper valve flat, with 12 narrow costæ, more or less obsolete at the umbone.

DIMENSIONS (of larger upper valve).—Height and length, 40 mm.

REMARKS.—Two upper valves of this species are contained in the collection, the larger having its inner surface covered with parasitic annelid tubes and a bryozoan (*Cellepora*).

HORIZON.—Miocene (Helvetian).

DISTRIBUTION.—Poland (Eichwald); near Lisbon (G. B. Sowerby); Russian Armenia (Abich); Vienna Basin (Hoernes). Egypt: Nile Valley (Fuchs); Camp 22. Coll. Geol. Surv. Egypt, No. 324, Box No. 26^{xxxx} *a*.

PECTEN BEUDANTI, Basterot.

Pecten Beudanti, Basterot, "Desc. Tert. Sud-Ouest France": Mém. Soc. Hist. Nat. Paris, vol. ii (1825), pt. 1, p. 74, pl. v, figs. 1*a-c*. Hoernes, "Foss. Moll. Tert.-Beck. Wien": Abhandl. k. k. geol. Reichs., vol. iv (1867), p. 399, pl. lix, figs. 1–3. Sacco: Moll. Terz. Piemonte, etc., 1897, pt. xxiv (Pectinidæ), p. 62, pl. xx, figs. 1–8.

DESCRIPTION.—Species characterized by its valves bearing very elevated, rounded, and radial costæ (14–16), ornamented with fine, closely-set, regular, lamellose, and transverse striæ. The lower valve is very convex, furnished with an incurved umbone, a moderately short cardinal line having vertically striated auricles of apparently equal size; the upper valve is flat and sometimes rather concave.

DIMENSIONS (of largest lower valve).—Height, 85 mm.; length, 95 mm.; diameter, 20 mm.

REMARKS.—This species need not be confused with either *P. solarium* of Lamarck or *P. Tournali*, which are forms of somewhat similar ornament, but possessing a convexity in both valves. Sacco's examples from Italy, although of rather smaller size and recognized under varietal names, appear to exhibit the general structural features of this species. The occurrence of this shell in Egypt is recorded here for the first time.

HORIZON.—Miocene (Helvetian).

DISTRIBUTION.—Bordeaux; Portugal (Sowerby); Constantine (Coquand); Italy; Switzerland; Vienna Basin. Egypt: Camp 22. Coll. Geol. Surv. Egypt, No. 322, Box No. 14*a*.

PECTEN CRISTATO-COSTATUS, Sacco.

Pecten cristato-costatus, Sacco: Moll. Terz. Piemonte, etc., 1897, pt. xxiv, p. 64, pl. xxi, figs. 1–7.

DESCRIPTION.—*Testa affinis P. subarcuatus*, Tourn., *sed in valva dextera costæ radiales valde elatiores, strictiores, acutiores, subtriangulares, sulcis profundissimis* (*costis latioribus*) *disjunctæ*. (Sacco.)

A single lower valve from Egypt appears to belong to this species, although the radial costæ become rounder as they reach the ventral margin, and their terminations are ornamented with extremely fine transverse striæ. In all other characters it is extremely like Sacco's shell. Costæ 18–20.

DIMENSIONS (of a lower valve).—Height, 40 mm.; length, 41 mm.; diameter, 11 mm.

REMARKS.—This species is closely related to *Janira benedicta* (Lamarck), Fontannes, from the Pliocene of the Rhône Valley, and differs mainly in possessing a greater number of ribs.

HORIZON.—Miocene (Helvetian).

DISTRIBUTION.—Italy. Egypt: Camp 19. Coll. Geol. Surv. Egypt, No. 371, Box No. 25^{x} *a*.

PECTEN ESCOFFIERÆ, Fontannes.

Pecten Escaffieræ, Fontannes: Etudes Tert. Bassin Rhône, 1878, pt. iii, p. 95, pl. v, fig. 1. Fuchs: Palæontographica, vol. xxx (1883), p. 24 (42), pl. viii (iii), figs. 9–12.

DESCRIPTION.—Shell small, subtriangular, and with a moderately convex right valve, bearing about 18 subrotund, elevated costæ; the sculpture consists of fine concentric striæ in the grooves, which become more or less lamellar on the depressed summits of the ribs.

DIMENSIONS (of right valve).—Height and length, 21 mm.; diameter, 5 mm.

REMARKS.—The collection contains only a right valve of this species. Fuchs has already recognized it from Egyptian rocks.

HORIZON.—Miocene (Helvetian).

DISTRIBUTION.—Visan Basin (Fontannes). Egypt: Siwa (Fuchs); Camp 22. Coll. Geol. Surv. Egypt, No. 324, Box No. 26^{xx} *a*.

PECTEN (ÆQUIPECTEN) MALVINÆ, Bois de Montpéreux.

Pecten Malvinæ, Bois de Montpéreux: Conch. Foss. Wolhyni-Podolien, 1831, p. 71, pl. v, figs. 2, 3.

Pecten opercularis, Goldfuss: Petrefacta Germaniæ, vol. ii (1833), p. 62, pl. xcv, figs. 6*a–b* (*non c* and *d*) (Lamarck, *non* Linnæus).

Pecten Malvinæ, Hoernes, "Foss. Moll. Tert.-Beck. Wien": Abhandl. k. k. geol. Reichs., vol. iv (1867), p. 414, pl. lxiv, figs. 5*a*, *b*. Fuchs: Palæontographica, vol. xxx (1883), p. 24 (42).

Æquipecten Malvinæ, var. *acuticostulata*, Sacco: Moll. Terz. Piemonte, etc., 1897, pt. xxiv, p. 16, pl. iii, figs. 36–40.

DESCRIPTION.—Both valves of this shell are convex and circular in shape, with a variable number of longitudinal costæ; the original description gives 30–35, Hoernes mentions 30, whereas Fuchs says that the average number is 21, which agrees best with what is seen on the Egyptian specimens. The ribs are simple over the umbonal region, but afterwards split up into three or four divisions, with minute interstitial spaces between each; both the ribs and the spaces are ornamented with lamellose and concentric

striations, which become more remote and lamellar near the margin.

Dimensions (of best specimen).—Height and length, 50 mm.

Remarks. — In adopting a subgeneric name, it may be mentioned that Sacco recognizes this shell under *Æquipecten* of Paul Fischer, on account of its similarity to the type, *P. opercularis*. It is indeed difficult to separate *P. Malvinæ* from the Linnæan species, except that it is somewhat less circular and fan-shaped. Hoernes' work must be referred to for a longer synonymy of the species than is here offered.

Horizon —Miocene (Tortonian).

Distribution.—Poland; Vienna Basin; Touraine; Italy; Persia (Fuchs). Egypt: Jebel Geneffe (Fuchs); no locality recorded for the present Egyptian specimens. Coll. Geol. Surv. Egypt, No. 624, Box No. 22*a*.

PECTEN (ÆQUIPECTEN) ZITTELI, Fuchs.

Pecten Zitteli, Fuchs: Palæontographica, vol. xxx (1883), p. 41 (23), pl. vii (ii), figs. 1–12.

Æquipecten Zitteli, Sacco: Moll. Terz. Piemonte, etc., 1897, pt. xxiv, p. 31.

Description.—Shell suborbicular, furnished with 13–15 broad, radial costæ, and a series of corresponding deep grooves; ribs elevated and subdivided into minor grooves and ridges; ornamentation closely lamellose.

Dimensions (of one valve).—Height, 48 mm.; length, 48 mm; diameter, 10 mm.

Remarks.—This species belongs to the group of *Pecten opercularis* which Fischer has named *Æquipecten*, and is related to *P. Malvinæ* and *P. cavarium* of Fontannes. The Egyptian examples are in a good state of preservation.

Horizon.—Miocene (Helvetian).

Distribution.—Egypt: Oasis Siwa (Fuchs); Camp 19. Coll. Geol. Surv. Egypt, No. 371, Box No. 25*a*.

PECTEN (AMUSSIOPECTEN) BURDIGALENSIS, Lamarck.

Pecten Burdigalensis, Lamarck: Annales Muséum, vol. viii (1806), p. 355. Hoernes, "Foss. Moll. Tert.-Beck. Wien": Abhandl. k. k. geol. Reichs., vol. iv (1867), p. 418, pl. lxv. Fuchs: Denk. Akad. Wiss. (Wien), vol. xxxviii (1878), pt. 2, p. 37.

Amussiopecten Burdigalensis, Sacco: Moll. Terz. Piemonte, etc., 1897, pt. xxiv, p. 53, pl. xv, figs. 1–7.

Description.—Species of suborbicular shape, with the lower valve more convex than the other; auricles small and of equal size; valves ornamented externally with 12–14 distant, broad, slightly elevated, radial costæ, which are crossed by extremely fine and closely-set concentric striations.

Remarks.—The Egyptian specimens, although somewhat imperfect, may be readily recognized as this large and well-known species.

Dimensions.—Height, 80 mm.; length, 85 mm.; diameter (both valves in contact), 20 mm.

Sacco's name of *Amussiopecten* was founded to include rather large, but graceful, pectinoid shells, bearing internal costæ and

outwardly a series of depressed ribs; both valves being convex and slightly gaping.

Horizon.—Miocene (Helvetian).

Distribution.—Bordeaux; Gironde; Portugal; Sardinia; the Azores; Vienna Basin; Constantine, etc. Egypt: Jebel Geneffe (Fuchs); 9 kilometres S.S.W. of Camp 22. Coll. Geol. Surv. Egypt, No. 355, Box No. 15*a*.

PECTEN, sp.

Remarks. — Three valves of different pectinoid shells, too imperfect for determination.

Horizon.—Miocene (Helvetian).

Distribution. — Egypt: Camp 22. Coll. Geol. Surv. Egypt, No. 324, Box No. 26^{x} *a*.

Genus AMUSSIUM [AMUSIUM], Chemnitz.

Conchyl. Cabinet, vol. vii (1784), p. 284, pl. lxi, fig. 595.

Type.—*Ostrea pleuronectes*, Linnæus.

AMUSSIUM CRISTATUM, Bronn, sp. (Pl. VIII, Fig. 6.)

Ostrea pleuronectes, Brocchi: Conch. Foss. Subapennina, vol. ii (1814), p. 573 (*non* Linnæus).

Pecten cristatus, Bronn: Zeitsch. Mineralogie (Leonhard), vol. ii (1828), p. 542. Hoernes, "Foss. Moll. Tert.-Beck. Wien": Abhandl. k. k. geol. Reichs., vol. iv (1867), p. 419, pl. lxvi, fig. 1.

Amussium cristatum, Sacco: Moll. Terz. Piemonte, etc., 1897, pt. xxiv, p. 47, pl. xiii, figs. 30, 31; pl. xiv, fig. 1.

Pecten cristatus, Repelin: Bull. Soc. Géol. France, sér. III, vol. xxv (1897), p. 130.

Pecten (*Cornelia*) *cristatus*, Mayer-Eymar: Palæontographica, 1898, vol. xxx, pt. 2, p. 65.

Description.—Shell depressed, nearly orbicular, with a smooth outer surface, and internally possessing 26–32 elevated, radial costæ, which are acuminate and slightly curved at their terminations, and do not quite reach the ventral margin.

Remarks.—This species is represented in the collection by a single fragment attached to a lower valve of *Pecten acuticostatus*. It is the internal portion of a valve showing three pairs of costal rays with bent acuminate ends, the intervening space between each pair having a maximum width of 9 millimètres. According to Mayer-Eymar this species ranges from Helvetian to Sicilian times in the neighbourhood of the Pyramids.

Horizon.—Miocene (Tortonian).

Distribution.—Vienna Basin; Southern France; Italy; Sicily; Sardinia; Algeria (Repelin), etc. Egypt: probably from Camp 21. Coll. Geol. Surv. Egypt, No. 365, Box No. 20^{x} *a*.

Genus SPONDYLUS, Linnæus.

Systema Naturæ, 10th ed. (1758), p. 690.

Type.—*S. gæderopus*, Linnæus.

SPONDYLUS, sp.

Spondylus, sp., cf. *crassicostatus*, Fuchs: Palæontographica, vol. xxx (1883), p. 25 (43), pl. viii (iii), fig. 14.

Description.—The valves are suborbicular, compressed, and ornamented with fine, closely arranged, tortuous ribs, which separate

wider and more prominent costæ having a lamellar or funnel-shaped structure. These larger costæ are broader and less numerous on the right or lower valve than on the left.

Dimensions.—Height, 60 mm.; length, 65 mm.; diameter, 32 mm.

Remarks.—Only one example of this shell is in the collection, consisting of a pair of fragmentary valves *in situ*, though preserving no dorsal characters of any moment and showing merely the slightest indication of one of the lateral auricles. So worn is the specimen that the asperities of the test are a good deal modified, the bases only of the sharp elongate spines, so prominent a feature in recent *Spondyli*, being present. It appears to differ from *S. crassicostatus* in its rounder, more compressed valves and thinner test, and from *S. gæderopus* in the lower valve exhibiting no trace of a foliaceous growth. It probably represents an intermediate form between these two species, which with better material at hand might be worthy of a new specific name. The fragmentary shell figured by Fuchs from Egypt corresponds in most details with the present specimen.

Horizon.—Miocene (Tortonian).

Distribution.—Egypt: Siwa (Fuchs); no locality recorded for this specimen. Coll. Geol. Surv. Egypt, No. 623, Box No. 21*a*.

Genus AXINÆA, Poli.

Testacea Siciliæ, vol. i (1791), p. 32.

Type.—*Arca pilosa*, Linnæus.

AXINÆA PILOSA, Linnæus, sp.

Arca pilosa, Linnæus: Systema Naturæ, 12th ed. (1767), vol. i, pt. 2, p. 1,143, Nos. 181, 182.

Pectunculus glycimeris and *P. pilosa*, Searles Wood, "Mon. Crag Moll. England": Mon. Palæontographical Soc., 1850, p. 66, pl. ix, fig. 1 (*pars*).

Pectunculus pilosus, Hoernes, "Foss. Moll. Tert.-Beck. Wien": Abhandl. k. k. geol. Reichs., vol. iv (1864), p. 316, pl. xl, figs. 1, 2; pl. xli, figs. 1–10. Seguenza, "Form. Terz. Reggio (Calabria)": Mem. R. Accad. Lincei, ser. III, vol. vi (1880), pp. 282, 360.

Description.—This is a suborbiculate, equilateral species, convex, and substriated; umbones incurved; margin crenulated. Shell closely related to *Arca glycimeris* of Linnæus, though differing from it in never departing from the regular or equilateral condition; that species being frequently oblique in shape. Searles Wood combined the two under *P. glycimeris*, but more modern authors have treated them as separate species, a plan adopted on the present occasion.

Remarks.—Two examples illustrate this species; they are partial casts showing remnants of the thick test in places. The more perfect one has the valves *in situ*, and exhibits the longitudinal striations together with a series of concentric growth-lines. On the sides are prominent oblique ridges representing the inner margins of the large adductor scars.

Dimensions.—Height, 75 mm.; length, 71 mm.; diameter, 46 mm.

Horizon.—Miocene (Helvetian).

Distribution.—Found recent in the Mediterranean Sea; and fossil in N. and S. Italy; Poland; Morea; S. France; Rhône Basin; near Lisbon; England; Vienna Basin; Azores; Oran, etc. Egypt: Camp 22. Coll. Geol. Surv. Egypt, No. 325, Box No. 57*a*.

Genus CARDIUM, Linnæus.

Systema Naturæ, 10th ed. (1758), p. 678.

Type.—*C. costatum*, Linnæus.

CARDIUM, sp. (Pl. IX, Figs. 3, 4.)

Remarks.—Under this genus are placed three casts of shells with attached valves, which are tumid, oblique, and elongate, and furnished with incurved, anterior, nearly contiguous umbones, beneath being an oval excavation. One of the specimens is covered with obscure vertical ribbing on its left valve, and still more obscure indications of concentric sculpture. An obtuse, postero-median, oblique carination proceeds from the beaks to the ventral region, forming the inner margin of the posterior area. This form appears to be related to *Cardium discrepans*, Basterot, a species common to the Miocene of Southern France, N. Italy, etc.

Dimensions.—Height, 45 mm.; length, 43 mm.; diameter, 30 mm.

Horizon.—Miocene (Tortonian).

Distribution.—Egypt: Camp 9. Coll. Geol. Surv. Egypt, No. 642, Box No. 53*a*.

Genus LUCINA, Lamarck.

Mém. Soc. Hist. Nat. Paris, 1799, p. 84.

Type.—*Venus edentula*, Linnæus.

LUCINA MULTILAMELLATA ?, Deshayes. (Pl. VIII, Fig. 7.)

Lucina multilamellata, Deshayes: Encyclopédie Méthodique, vol. ii (1830), p. 377 (not figured). Hoernes, "Foss. Moll. Tert.-Beck. Wien": Abhandl. k. k. geol. Reichs., vol. iv (1864), p. 227, pl. xxxiii, fig. 2. Fuchs: Palæontographica, vol. xxx (1883), p. 39 (21), pl. vi (i), fig. 12.

Description.—The Egyptian collection contains a series of casts belonging to a lenticular and suborbicular shell with both valves in contact, which resembles very strongly Fuchs' interpretation of this species as figured by him in the *Palæontographica*. The surface irregularities on the interior of the valves, alluded to by Deshayes in the original description, are well seen in the specimens, besides some obscure indications of radial striæ.

Dimensions.—Height, 52 mm.; length, 54 mm.; diameter, 24 mm.

Horizon.—Miocene (Helvetian).

Distribution.—Bordeaux; Vienna Basin. Egypt: Siwa (Fuchs); between Camps 19 and 22 (2*c*) and S.E. of Camp 19 (48*c*). Coll. Geol. Surv. Egypt, No. 830, Box No. 2*c*; No. 871, Box No. 48*c*.

Genus TELLINA, Linnæus.

Systema Naturæ, 10th ed. (1758), p. 674.

Type.—*T. radiata*, Linnæus.

TELLINA LACUNOSA, Chemnitz.

Tellina lacunosa, Chemnitz: Conchylien-Cabinet, vol. vi (1782), p. 92, pl. ix, fig. 78.
Tellina papyracea, Gmelin: Linnæus' Systema Naturæ, 13th ed. (1790), vol. i, pt. 6, p. 3,231.
Tellina tumida, Brocchi: Conch. Foss. Subapennina, vol. ii (1814), p. 513, pl. xii, fig. 10.

Tellina lacunosa, Hoernes, "Foss. Moll. Tert.-Beck. Wien": Abhandl. k. k. geol. Reichs., vol. iv (1859), p. 91, pl. ix, fig. 1. Fuchs: Denk. Akad. Wiss. (Wien), vol. xxxviii (1878), pt. 2, p. 36.
Tellina tumida, Seguenza, "Form. Terz. Reggio (Calabria)": Mem. Atti R. Accad. Lincei, ser. III, vol. vi (1880), p. 73.

DESCRIPTION.—Shell roundly ovate, ventricose, possessing a wide postero-median depression in the right valve and a peculiarly twisted ventral region.

DIMENSIONS.—Height, 48 mm.; length, 53 mm.; diameter, 25 mm.

REMARKS.—Represented by some casts exhibiting attached valves, which have been compared with recent examples of this species from Guinea, and found to agree in all essential details. They show the central depression of the right valve, a more inflated left valve, and the typical flexuosity of the ventral area. No scar impressions are visible, but the posterior oblique area, reaching from the beaks to the infero-ventral margin, is well defined. Two valves, Box No. 48^{x} *c*, are doubtfully referred to this species; they may be young forms.

HORIZON.—Miocene (Burdigalian).

DISTRIBUTION.—Recent, from the Guinea Coast; fossil from Italy, Switzerland, South of France, Vienna Basin, etc. Egypt: Jebel Geneffe (Fuchs); Camp 6 (52*a*) and S.E. Camp 19 (48^{x} *c*). Coll. Geol. Surv. Egypt, No. 641, Box No. 52*a*; No. 871, Box No. 48^{x} *c*.

Genus MERETRIX, Lamarck.

Mém. Soc. Hist. Nat. Paris, 1799, p. 85.

TYPE.—*Venus meretrix*, Linnæus.

MERETRIX ERYCINA, Linnæus, sp.

Venus erycina, Linnæus: Systema Naturæ, vol. i (1767), pt. 2, p. 1,131.
Cytherea erycinoides, Lamarck: Hist. Nat. Anim. sans Vert., vol. v (1818), p. 581.
Callista erycina, H. & A. Adams: Genera of Recent Mollusca, vol. ii (1857), p. 425.
Cytherea erycina, Hoernes, "Foss. Moll. Tert.-Beck. Wien": Abhandl. k. k. geol. Reichs., vol. iv (1861), p. 154, pl. xix, figs. 1, 2.
Cytherea erycinoides, Seguenza, "Form. Terz. Reggio (Calabria)": Mem. Atti R. Accad. Lincei, ser. III, vol. vi (1880), pp. 52, 60, 119.

DESCRIPTION.—Shell transversely oval, cuneiform; wide, short, and round anteriorly; round, acuminate, and produced in rear; surface ornamented with depressed concentric sulcations.

DIMENSIONS (valves *in situ*).—Height, 48 mm.; length, 37 mm.; diameter, 23 mm.

REMARKS.—The Egyptian specimens referred to this species are somewhat obscure and imperfect, though that from which the above dimensions are taken is in fairly good condition and shows the shape of the shell as well as the typical parallel, obtuse sulcations which ornament its valves. There is a long synonymy to the species which is well set out in Hoernes' work, but not repeated here.

HORIZON.—Miocene (Burdigalian).

DISTRIBUTION.—Bordeaux; North and South Italy; Gironde Basin; Rhône Basin; Portugal; Vienna Basin, etc. Egypt: Camp 6. Coll. Geol. Surv. Egypt, No. 640, Box No. 51*a*.

MERETRIX, allied to HAGENOWI, Dunker, sp.

Cytherea Hagenowi, Dunker: Novitates Conchologicæ, 1865, pt. ii, No. 2, p. 13, pl. iv, figs. 13–15; Zeitschr. Malakozoologie (Menke & Pfeiffer), 1849, p. 184.

Description. — Shell characterized by its rounded posterior margin and rather shallow valves, ornamented with numerous regular, concentric, and rather obsolete plications.

Remarks.—An imperfect right valve contained in this collection appears to be closely allied to this species, and differs chiefly in exhibiting a strongly pronounced concentric sculpture. It, however, compares favourably with a recent specimen from the Red Sea in the British Museum identified as this species.

Dimensions.—Height, 50 mm.; length, 60 mm.; diameter, about 12 mm.

Horizon.—Miocene (Burdigalian).

Distribution. — Egypt: Camp 6. Coll. Geol. Surv. Egypt, No. 640, Box No. 51^{x} *a*.

MERETRIX LAMARCKI, Agassiz, sp.

Cytherea nitidula, Basterot, "Desc. Géol. Tert. Sud-Ouest France": Mém. Soc. Hist. Nat. Paris, vol. ii (1825), pt. 1, p. 91, *non* Lamarck. Goldfuss: Petrefacta Germaniæ, vol. ii (1840), p. 239, pl. cxlix, fig. 11.

Cytherea Lamarcki, Agassiz, "Iconographie Coquilles Tertiaires": Nouv. Mém. Soc. Helvétique Sci. Nat., vol. vii (1845), p. 39, pl. vii, figs. 1–4. Hoernes, "Foss. Moll. Tert.-Beck. Wien": Abhandl. k. k. geol. Reichs., vol. iv (1861), p. 153, pl. xviii, fig. 5.

Description.—Species ovate, transverse, ventricose, inequilateral; wide and round anteriorly and in rear; lunule prominent; posterior area lanceolate; margins closed.

Dimensions.—Height, 44 mm.; length, 56 mm.; diameter, 28 mm.

Remarks.—An internal cast of both valves *in sitû* represents this shell. Its careful comparison with the excellent figures of Agassiz and Hoernes leaves no room for doubt that it belongs to this form. The elegant rounded and ventricose character of this species is well maintained in the specimen.

Horizon.—Miocene (Burdigalian).

Distribution. — Bordeaux; Westphalia; Vienna Basin, etc. Egypt: Camp 6. Coll. Geol. Surv. Egypt, No. 641, Box No. 52^{x} *a*.

[BIVALVE: INDETERMINABLE.]

Remarks. — A badly preserved specimen — not identifiable, but probably belonging to the genus *Meretrix*.

Horizon.—Miocene (Burdigalian).

Distribution. — Egypt: Camp 6. Coll. Geol. Surv. Egypt, No. 640, Box No. 51^{x} *a*.

Genus VENUS, Linnæus.

Systema Naturæ, 10th ed. (1758), p. 684.

Type.—*Venus chione*, Linnæus.

VENUS BURDIGALENSIS ?, Mayer-Eymar.

Venus Burdigalensis, Mayer-Eymar: Journ. Conchyliologie, sér. ii, vol. iii (1858), p. 298; ibid., sér. ii, vol. iv (1860), pl. v, fig. 4; Syst. Verz. Foss. Reste Madeira, etc., 1864, p. 19. Hoernes, "Foss. Moll. Tert.-Beck. Wien": Abhandl. k. k. geol. Reichs., vol. iv (1861), p. 129, pl. xv, fig. 1.

Remarks.—Three internal casts of a *Venus* with attached valves are referred doubtfully to this species. They are of similar proportionate size to the type, and preserve the same obliquely curved outline of the dorso-posterior area. The lunule is large and deeply excavated, whilst the escutcheon is long, wide, and lanceolate. No pallial impression is seen, and the muscular scars are nearly obsolete.

Dimensions.—Height, 60 mm.; length, 68 mm.; diameter, 38 mm.

Horizon.—Miocene (Burdigalian).

Distribution.—Bordeaux; Vienna Basin; Island of Baixo, Madeira. Egypt: Camp 6. Coll. Geol. Surv. Egypt, No. 1,002, Box No. 47*c*.

VENUS, sp.

Remarks.—Represented by two imperfect casts, which exhibit a deep excavation beneath the beaks corresponding to the lunule; on the other side is a prominent lanceolate depression representing the escutcheon area. A concentric lamellose ornamentation is somewhat obscurely seen in one of the specimens. They are probably the moulds of *Venus plicata*, Gmelin.

Dimensions.—Height, 35 mm.; length, 40 mm.; diameter, 23 mm.

Horizon.—Miocene (Tortonian).

Distribution. — Egypt: Camp 9. Coll. Geol. Surv. Egypt, No. 642, Box No. 53^{x} *a*.

EXPLANATION OF PLATE VIII.

Turritella terebralis, Lamarck. Helvetian of Jebel Geneffe.

Fig. 1.—Several examples on a small slab of yellowish sandstone.

Pyrula condita, Brongniart. Helvetian of Camp 22.

Fig. 2.—Back view of specimen.

Fig. 3.—Front aspect, showing aperture.

Cancellaria, sp. Helvetian: between Camps 19 and 22.

Fig. 4.—Front aspect of shell.

Fig. 5.—Back view of same specimen.

Amussium cristatum, Bronn, sp. Tortonian: probably from Camp 21.

Fig. 6.—Fragment showing the internal surface of a valve and its pairs of costal rays; attached to a valve of *Pecten acuticostatus*.

Lucina multilamellata?, Deshayes. Helvetian: between Camps 19 and 22.

Fig. 7.—Cast of specimen with indications of radial striæ.

EXPLANATION OF PLATE IX.

Ostrea Fuchsiana, sp. nov. Tortonian: from Camp 19.

Fig. 1.—External view of lower valve, exhibiting the radial ridges and spines.

Fig. 2.—Internal view of same specimen, showing small ligamental area and extensive muscular scar.

Cardium, sp. Tortonian: Camp 9.

Fig. 3.—Cast of a specimen showing vertical striation.

Fig. 4.—Umbonal view of same specimen.

[The figures on both Plates are drawn natural size.]

V.—Zones and 'Chronological' Maps.

By A. J. Jukes-Browne, B.A., F.G.S.

MODERN stratigraphical geologists, both those who study the Palæozoic and those who are occupied with the Neozoic rocks, are largely concerned with the establishment of zones; in other words, the zonal method of subdivision has been recognized as the best means of correlating the stratigraphical succession in one area with that of another. But when it comes to giving an exact definition of a zone there does not appear to be the same unanimity of opinion, and consequently it seems desirable that some well-considered definition of a zone should be put forward and discussed.

The conceptions of a zone which have from time to time been expressed by different English writers may, I think, be arranged in two sets, according as they give prominence to one of two different ideas. One set of writers have regarded the essential idea of a zone to be an assemblage of fossils which could be traced over a more or less extended geographical area; other writers consider a zone to be an actual belt or band of stratified rock characterized by a certain number of fossil species.

Most of the earlier English writers on this subject used the term 'zones of life,' and it is probable that this imparted to some minds an erroneous impression that such zones were zoological assemblages or faunas, and were only useful as aids in determining a sequence which was established on a different basis.

Another phrase frequently used was 'Ammonite zones,' which naturally led to the fallacy that zones were established solely on the occurrence of certain species of Ammonites without reference to the distribution of other kinds of fossils.

One of the earliest investigators of zones in this country was Dr. Thomas Wright, and though he makes use of the terms 'life-zones' and 'Ammonite zones,' yet it is quite clear from his writings that by a zone of the Lias he means an actual subdivision of the Lias, a group of beds containing an assemblage of fossils, some of which are restricted to the zone.[1]

Mr. R. Tate, writing in 1867 of Liassic zones, says: "The zone is a zoological one and signifies an assemblage of species, and whether you call it Lias *a* or Lias *β*, or the zones of *Ammonites planorbis* and *Ammonites angulatus*, the succession of faunas in the Lower Lias still remains patent, and it is to these several faunas that the term Ammonite zone is applied."[2]

This passage is somewhat confused, for he defines a zone as a fauna, and yet says it might equally well be called Lias *a*, *β*, etc., which are stratigraphical subdivisions. In 1875, however, he expresses himself much more clearly, for he writes that "the strata [of the Lias] admit of a grouping into zones after their palæontological characters, and further into regions of Ammonites, a classification as much in harmony with facts as that of the Oolitic rocks into formations."[3]

[1] Quart. Journ. Geol. Soc., vol. xvi (1860), p. 374; and "The Lias Ammonites," Mon. Pal. Soc., 1878–9.

[2] Quart. Journ. Geol. Soc., vol. xxiii, p. 300.

[3] Quart. Journ. Geol. Soc., vol. xxxi, p. 493.

The mistaken ideas prevalent between 1860 and 1870 respecting zones are reflected by Mr. C. Moore, who makes some observations on the "value of zones of zoological life," which show that he thought the fauna of a zone was supposed to be strictly confined to it, and he indicates some exceptions to the supposed law.[1]

Professor Phillips seems to have regarded zones as relating to the succession of species belonging to some single order or class; thus, after referring to the useful results obtained from a study of 'Ammonite zones,' he says: "the same method . . . . ought to be applied in all cases of large groups; we should have zones of Echinodermata, Brachiopoda, etc., treated independently of the Cephalopoda, with which they would not necessarily synchronize, and finally all would be combined into a true system of geological chronology."[2] No doubt such a study would be very useful, but the idea of a zone conveyed by Phillips is not that held and expressed by those who were then actually working at zones; it does not even imply a zonal fauna, much less a set of strata identified by such a fauna.

In an earlier publication, however, Phillips seems to have used the term zone in a sense which approaches more closely to its normal signification. He says:[3] "A palæontologist finds the whole Carboniferous Period one, though in it are several zones distinguishable by the prevalence of a few types and by the paucity or absence of others."

It is evident that the men of Phillips' generation were not consistent in their use of the term zone, and that few of them had seen the necessity of formulating a clear definition. Since 1880 this necessity has been more felt, and the value of the zonal method has been more fully recognized. In some quarters, however, there is still a lurking antagonism to it, and a disposition to regard it as a method which is based on a different principle from that which guides ordinary stratigraphical work. I hope, however, to show in the sequel that this is a mistake.

It is curious to find Mr. H. B. Woodward so late as 1892 defining a zone in a zoological and not a stratigraphical sense, and stating that "zones are assemblages of organic remains, of which one abundant and characteristic form is chosen as an index," though in a later paragraph he remarks that "the essential idea of a zone is that it marks a period of time."[4] It is quite true that one essential idea of a zone is that it corresponds to a period of time, but if so, it seems to me that it must also correspond with the depth of sediment formed during that period. This sediment, of course, will vary in depth and character from place to place, but it unquestionably forms a band or zone of sedimentary material, and it must be, to say the least, as correct to define a zone as a band of stratified rock as to call it an assemblage of fossils. This is certainly the view taken by most recent writers.

[1] Quart. Journ. Geol. Soc., vol. xxiii, p. 510.
[2] "Geology of Oxford," 1879, p. 132.
[3] Quart. Journ. Geol. Soc., vol. xvi (1860), Pres. Add., p. xxxviii.
[4] "On Geological Zones": Proc. Geol. Assoc., vol. xii, p. 298.

To select a few out of many authorities the following may be mentioned :—

(1) Professor Lapworth states that *stages* or groups of strata "are divisible into zones or minor groups of strata." See "Introductory Textbook" (Page & Lapworth), 1888, p. 125, and "Intermediate Textbook," 1899, p. 155.

(2) Kayser & Lake, who give the same definition. ("Textbook of Comparative Geology," 1895, p. 6.)

(3) Sir A. Geikie—"Textbook of Geology," first edition (1882), p. 635, and third edition (1893), p. 678—defines a zone as a bed, or a limited number of beds, characterized by one or more distinctive fossils.

(4) Mr. S. S. Buckman, who remarks : "I take it that of late years the stratum or strata characterized by an assemblage of organic remains, more or less peculiar thereto, has been regarded as a zone." (Quart. Journ. Geol. Soc., xlix, 1893, p. 481.)

(5) Mr. J. E. Marr, who defines zones as "belts of strata, each of which is characterized by an assemblage of organic remains, of which one abundant and characteristic form is chosen as an index." ("Principles of Stratigraphical Geology," 1899, p. 68.)

In view of this consensus of recent opinion it is surprising to find that the reviewer of Mr. Marr's book in the GEOLOGICAL MAGAZINE for February dissents from the definition just quoted, and says: "Zones must be identified by fossils, and not by the strata; and therefore they serve to indicate periods of time rather than masses of sediment. We could hardly speak of a zone which is represented partly in Upper Greensand, partly in Red Chalk, and partly in Gault Clay as forming a belt of strata" (op. cit., p. 85).

This is not a very lucid statement, but the reviewer evidently objects to a zone being regarded as a definite stratigraphical unit; he is attached to the old lithological method of classification, and does not believe in mapping by fossils. But he should not find fault with Mr. Marr for giving expression to the general belief of the day—and, as we have seen, according to that general belief a zone is a group of strata; further, as a zone literally means a girdle or belt, it is correct to use that word in defining it.

Again, if the same assemblage of fossils can be traced from a Greensand area through a Gault area and into one of Red Chalk, does not that assemblage occupy a belt of strata? The belt may vary in thickness, but that does not matter; it may not only pass laterally from sand to clay, but it may in one district include both sand and clay, and such variation does not make it any the less a band or belt of strata.

The zonal method, in fact, is merely a development of William Smith's original method of identifying formations by means of the organic remains which they contain. Just as one stage is identified and distinguished from others by the assemblage of fossils it contains, so in its turn is the zone identified by its fossils. The stage is not a fauna, but a subdivision of a series or system of strata, and in like manner the zone is a subdivision of a stage. The reviewer appears

to be quite unaware that this is the accepted view of a zone; he may, of course, still maintain that he is right and that the authorities I have quoted are wrong, but if so, something more satisfactory in the way of argument will be expected from him.

Why, again, should the reviewer deem it impossible to produce such maps as Mr. Marr has expressed a desire to see—maps in which the colours should rigidly signify stages or divisions founded on palæontological evidence, and not in any way on the lithological facies of the rocks. He intimates that the Cretaceous stages of Albian, Cenomanian, etc., could not be mapped in this way, but I have probably had as much experience of these strata as the reviewer, and I will undertake to say that they could be mapped by palæontological evidence, though of course the surveyor would have to know his fossils well to start with.

It is a mistake to suppose that the only kind of geological map which can be of any use is one showing the different kinds of rock which occur in a given district. That is doubtless the kind of map which is best suited for economical purposes, and as such it is the kind of map issued by our Geological Survey and by the Service de la Carte Géologique de la France; but that is, after all, only one kind of geological map. There is certainly another kind, more strictly scientific and just as truly stratigraphical; this may be called a chronological map, though a better term might be found for it, and the smallest division shown by colour on such a map would be a stage, such as Bathonian or Turonian.

There would be no more difficulty in producing a series of such maps than there is in drawing a line between the Gault and the Upper Greensand in Surrey and Hampshire, a task which I commend to the reviewer, and to any geologists who still believe in the exceeding usefulness of such divisions as Gault and Upper Greensand.

As a matter of fact, I am informed by my friend Professor Barrois that the Geological Service of France is actually now issuing such maps; sheets on a scale of $\frac{1}{320000}$, with a system of coloration by stages and showing what we will call the 'solid geology' only, without obscuration by superficial deposits.

When, therefore, Mr. Marr asserts that "for theoretical purposes two sets of chronological maps, one founded upon lithological differences, the other upon differences of fossil organisms, would be extremely valuable,"[1] he should be commended for his foresight, and he will doubtless be glad to know that in one country, at least, the need for such maps has not only been felt but met.

The mapping of zones would be a more difficult matter, though in many cases of well-established zones it could doubtless be done at once; but it is safe to say that in process of time, when the zonal succession in every formation has been more fully studied and fairly well established, the larger zonal divisions or groups of sub-zones could be distinguished on such maps, either by tints of the 'stage' colour or by a system of lettering.

[1] "Principles of Stratigraphical Geology," pp. 15 and 87.

VI. — On the Average Composition of British Igneous Rocks.

By Alfred Harker, M.A., F.G.S., Fellow of St. John's College, Cambridge.

THE subject of the average composition of collections of rocks has been dealt with in a paper published ten years ago by Mr. F. W. Clarke on "The Relative Abundance of the Chemical Elements."[1] The object of that paper was to arrive at an estimate of the mean chemical composition of the earth's crust, but incidentally the author shows a close correspondence between the mean compositions of groups of miscellaneous rocks from different regions. It appears from his figures that a moderate number of analyses—less than a hundred—if taken without any selection, is enough to give value to their mean. It may therefore be of interest to apply the method to our own country. I have accordingly collected published analyses of 397 British igneous rocks, viz., 195 English, 31 Welsh, 79 Scottish, and 92 Irish, and calculated their mean. By searching it would doubtless be possible to find additional analyses, though probably not many, and the number taken is quite sufficient for our purpose. I have taken all the complete analyses that I found, except a very few known to be faulty, since it is the essence of the statistical method that no selection should be exercised. Partial analyses I have not used, with the exception of 78 analyses of Malvern rocks by Timins, in which the alkalies were not estimated. The mean given by the 397 analyses (or in the case of the alkalies by 319) appears in Column I.

	I. British Rocks.	II. British Rocks (corrected).	III. American Rocks.
SiO_2 ...	58·75	58·46	59·77
TiO_2 ...	0·12	0·69	0·53
Al_2O_3 ...	15·64	15·13	15·38
Fe_2O_3 ...	5·34	5·34	2·65
FeO ...	2·40	2·40	3·35
MnO ...	0·15	0·40	0·09
MgO ...	4·09	3·84	4·40
CaO ...	4·98	4·98	4·81
Na_2O ...	3·25	3·25	3·61
K_2O ...	2·74	2·74	2·83
H_2O ...	2·23	2·23	1·51
P_2O_5 ...	0·02	0·25	0·21
	99·71	99·71	99·14

These figures, however, need some corrections for various reasons. In particular, certain constituents have not been determined in all cases. Titanic acid was estimated in 30 analyses only and recorded as 'traces' in 4 others. The mean for the 34 rocks is 1·39. This is doubtless too high a figure to be inserted in the general average, because titanic acid has usually been sought in such rocks (chiefly of basic and ultra-basic composition) as were expected to yield it in noteworthy quantity. Since some arbitrary assumption is

[1] Bull. Phil. Soc. Washington, vol. xi (1889), pp. 131–142; also in *Chemical News* for Jan. 17, 1890.

necessary, I have halved the figure, and taken the titanic acid as 0·69 per cent. The difference between this and 0·12 is to be subtracted from the silica and alumina, and half has been taken from each. The same reasoning does not apply, at least in the same degree, to manganese and phosphoric acid. Manganous oxide was estimated in 103 analyses and recorded as traces in 51. The mean for these 154 rocks is 0·40, and this figure may be adopted in the general average without fear of much error. The difference between 0·40 and 0·15 is to be subtracted from the magnesia. Phosphoric anhydride was estimated in 35 analyses only and recorded as traces in 20. The mean for these 55 rocks is 0·25, and this figure may be adopted in the general mean, the difference between this and 0·02 being accordingly subtracted from the alumina. The result as thus corrected is seen in column II. In the paper already cited Clarke gives the mean analysis of 880 miscellaneous rocks, American and others; but I quote for comparison, instead of this, a mean analysis of American rocks exclusively, given in a later work by the same author.[1] This, which is calculated from 680 complete analyses, supplemented by a number of partial analyses, is given in column III.

There are still certain points to be observed in comparing the two columns. In 157 of our 397 analyses ferrous oxide was not estimated. The figure for this constituent is therefore too low and that for ferric oxide correspondingly too high. Again, the water has not always been estimated in the same way. In many of the analyses only the loss on ignition has been determined, and by taking this as water I have no doubt increased unduly the figure for that constituent. Carbonic acid, chlorine, fluorine, and sulphur, when separately estimated in the analyses, have been discarded. These, of which only the first is of importance, are therefore partly included, together with 'loss' and errors, in the 0·29 per cent. required to make up the total to 100. This defect should really be somewhat greater, since a certain amount of ferrous oxide has been reckoned as ferric.

The British mean is seen to have a rather lower silica-percentage than the American, though it agrees closely enough with the figure (58·59) in Clarke's old mean for rocks from various quarters of the globe. The difference is perhaps not a significant one. As regards titanic acid and alumina, the two columns show a fair correspondence. The British rocks are evidently richer in iron than the American. The proportions of the two oxides are, as has been remarked, not correct, and it is not possible to rectify them; but converting the whole to ferric oxide, we get 8·01 for column II, as compared with 6·37 for column III. The relatively high percentage of manganese in the British rocks is certainly of significance, and must be regarded as a characteristic of the whole assemblage. The precise figure is not to be insisted upon, since it has been reached in a rather arbitrary fashion; but even in column I, where all rocks in which manganese had not been recorded were assumed to contain none, the

[1] Clarke & Hillebrand, "Analyses of Rocks": Bull. 148, U.S.G.S., 1897.

figure is very distinctly higher than Clarke's. We see next that the British rocks are poorer in magnesia, and rather poorer in soda than the American, while in lime and potash the two columns show no great disparity. The alkalies jointly amount to 5·99 in the one column as compared with 6·44 in the other. We might have anticipated a greater deficiency in alkalies in the British rocks, and also a more marked excess of lime, as compared with the American, since the majority of our rocks belong decidedly to what Iddings has styled the 'Sub-Alkali' rather than to the 'Alkali' group, while both groups are well represented in the United States. The apparently rather large percentage of water in column II must be due in part to the circumstances already noted. In phosphoric acid there is a sufficiently close agreement between the two averages.

If we were to separate the English, Scottish, and Irish rocks, and calculate averages for the several groups, we should find that these would be disturbed by principles of selection which have entered into the choice of the rocks analyzed. Thus we have a large number of analyses of Irish granites by Professor Haughton, while the Scottish granites have been comparatively neglected. This goes to make the Irish average more acid and the Scottish more basic than the general mean. Nevertheless, it would no doubt be possible to get results of interest for even smaller areas, provided that rocks sufficiently various in kind are included; and, if we take account of partial as well as complete analyses, we shall find for some areas a considerable body of data. For example, 96 igneous rocks from the English Lake District give a mean silica-percentage 58·75, not very different from that of the general average; but 82 examples from the Malvern Hills give only 54·81. The low figure in the latter case can scarcely be accidental. It is worthy of note, too, that of 78 igneous rocks from the Malverns, Timins estimated copper oxide in 21 and recorded traces in 11 others, the mean percentage being 0·23 for these 32 rocks, or 0·12 for the whole 78. This is at least twenty times as great as any probable estimate for the general average of rocks.

The mean specific gravity of a large number of igneous rocks from a given district will probably be found in some cases to be characteristic. Of the 397 analysed British rocks included above, specific gravities are given for 209, the mean value being 2·777. By including 527 miscellaneous igneous rocks from various districts of Britain, we find the mean specific gravity of the whole 736 to be 2·763. Taking the two special districts already mentioned, we find that 113 Lake District rocks give a mean specific gravity 2·737, decidedly below the average, while 38 from the Malverns give 2·841, which is decidedly above the average. The preponderance of basic rocks in Skye comes out less strikingly, 332 miscellaneous igneous rocks from that island giving a mean of 2·774. In all such calculations it is of course essential that no selection should be exercised, the rocks being taken at random so as fairly to represent the variety found within the district.

VII.—On the Dates of the "Paléontologie Française" of D'Orbigny.

By C. Davies Sherborn.

THE first six volumes of Cretaceous Fossils and the first two volumes of Jurassic Fossils, described in this work, were issued without exact dates, and consequently have caused much confusion in nomenclature.

Information has been obtained from many sources, but that from the *Neues Jahrbuch* seems on the whole more continuously exact.

CRETACEOUS SERIES.

Vol. I.—Cephalopoda.

Livr. 1–3,	1840 (N.J., 1840, p. 690).	One sheet to each livr.
3[4]–21,	1841 (N.J., 1841, p. 463).	
12[22]–17[27],	1841 (N.J., 1842, p. 104).	
28–32,	1841 (N.J., 1842, p. 235).	
33–42, pp. 431–662,	1842 (N.J., 1842, p. 455).	

The above is the evidence from the *Neues Jahrbuch* as regards vol. i, but it is evidently so carelessly recorded, markedly so in comparison with the later records, that one must take further evidence. We find that the Geological Society of London received as a present from the author livraisons 1–20, and of these livraisons 9 and 10 were received on January 4, 1841. It will be quite safe, therefore, to regard livrs. 1–10 as belonging to 1840. Now the *Neues Jahrbuch* says that each of the three first parts contained one sheet, and an examination of the volume shows that on this assumption livrs. 1–10 would contain 120 pp. (for the sheets are in 4's and 8's). The *Neues Jahrbuch* is very clear as to the pages contained in livrs. 33–42, and as this is the beginning of their careful record, one may accept the statement as accurate, and we are left with pp. 121–430 for the year 1841. My friend Mr. G. C. Crick, who has examined this volume with me, agrees in determining the date of vol. i, Cretaceous Cephalopoda, as—

pp. 1–120, 1840.
121–430, 1841.
431–662, 1842.
Supplément, 1847 (see below, vol. iii).

The further volumes present no difficulties, and there appears no reason to doubt the record furnished by the *Neues Jahrbuch*.

Vol. II.—Gasteropoda.

Livr. 43–48	pp. 1–80	1842	...	(N.J., 1842,	p. 843)
49–60	81–288	1843	...	1843	602
61–70	289–456	1843	...	1844	60

Vol. III.—Pelecypoda.

Livr. 71–76	pp. 1–96	1844	...	(N.J., 1844,	p. 461)
77–90	97–288	1844	...	1845	195
91–102	289–448	1845	...	1845	809
103–106	449–480	1846	...	1846	479
107–111	481–520	1846	...	1847	198
112–116	521–576	1847	...	1847	467
117–126	577–688 and Supplément to vol. i (Céph.), consisting of livr. 1 and 2, pp. 1–28, pls. ii–ix:				
		1847	...	(N.J., 1847,	p. 827)

Livr. 127–136	pp. 689–807	1848	...	(N.J., 1848,	p. 560)
Vol. IV.—Brachiopoda.	1–16				
137, 138	17–32	1848	...	1849	81
139–144	33–104	1849	...	1850	52
145–152	105–200	1850	...	1850	436
153–110 [160]	201–328	1850	...	1851	186
161–164	329–390	1851	...	1851	437
Vol. V.—Bryozoa.					
Livr. 165, 166	pp. 1–28	1851	...	(N.J., 1851,	p. 580)
165–168	1–60	1851	...	1851	683
169–176	61–188	1851	...	1852	61
177–182	189–265	1852	...	1852	308
183–188	266–376	1852	...	1852	606
189–194	377–472	1852	...	1852	945
195–202	473–600	1853	...	1853	448
203–208	601–792	1853	...	1853	820
209–214	793–984	1852 [3]	...	1854	328
215–218	985–1192	1854	...	1854	432
Vol. VI.—Echinoidea.					
Livr. 209 [219]–226	pp. 1–128	1854	...	(N.J., 1855,	p. 55)
227–238	129–256	1855	...	1855	683
239, 240	257–272	1855	...	1856	30
241–248	273–328	1856	...	1856	677
249, 250	329–352	1856	...	1857	156
251–254	353–384	1857	...	1857	318
255, 256	385–400	1858	...	1858	208
[?]	401–432	[1858]			
[?]	433–550	[1860]			

With p. 433 of this volume d'Orbigny's work finished; p. 434 begins with the following note:—

"Ici se termine le texte imprimé avant la mort de d'Orbigny. Ne voulant pas laisser ce volume inachevé, nous avons remis à M. Cotteau, qui à bien voulu se charger de les co-ordonner, les notes manuscrits laissées par l'auteur." (Note de l'éditeur, Août, 1859.)

As new species of Cotteau appear dated 1859 on pp. 495 and 548, pp. 433–550 would appear to date as 1860.

JURASSIC SERIES.

Vol. I.—Cephalopoda.					
Livr. 1–5	pp. 1–80	1842	...	(N.J., 1842,	p. 843)
6–11	81–144	1843	...	1843	602
12–16	145–192	1843	...	1844	60
17–19	193–224	1844	...	1844	461
20–27	225–312	1844	...	1845	195
28–33	313–368	1845	...	1845	809
34, 35	369–392	1846	...	1846	479
36–40	393–432	1846	...	1847	198
41	(plates only)		...	1847	467
42–45	433–464	1847	...	1847	827
46–50	465–496	1848	...	1848	560
51	497–504	1848	...	1849	81
52–54	505–520	1849	...	1850	52
55–58	521–568	1850	...	1850	436
59–62	569–632	1850	...	1851	186
63, 64	633–642				
Vol. II.—Gasteropoda.	1–16	1851	...	1851	437
65	17–32	1851	...	1851	580

Livr.	65, 66	pp. 33–48	1851	...	(N.J., 1851, p. 683)
	67–70	49–112	1851	...	1852 61
	71–73	113–152	1852	...	1852 308
	74–76	153–192	1852	...	1852 606
	77–79	193–232	1852	...	1852 945
	80–83	233–288	1853	...	1853 448
	84–86	289–336	1853	...	1853 820
	87–89	337–384	1852 [3]	...	1854 329
	90	385–392	1854	...	1854 432
	91–94	393–424	1854	...	1855 55
	95–100	425–472	1855	...	1855 683
	101	473–480	1855	...	1856 30
	102–105	481–512	1856	...	1856 677
	106	513–520	1856	...	1857 156
	106 [7], 108 [?]	521–536 537–end	1857 [1860]	...	1857 318

With p. 536 of this volume D'Orbigny's work finished; precisely the same editorial note is given on p. 537 as has been quoted under vol. vi of the Cretaceous Series, with the exception of the date, which is "Octobre" instead of "Août." Pages 537 to the end of this volume may therefore be regarded as dated 1860.

Started afresh in 1861, the Committee of Publication for the "Paléontologie Française" has followed the excellent practice of printing an official statement of the dates of publication in each volume. These present notes will, I trust, help to clear away many difficulties in zoological nomenclature.

NOTICES OF MEMOIRS.

THE DRIFT OR GLACIAL DEPOSITS OF AYRSHIRE. By JOHN SMITH. (Reprinted from the Transactions of the Geological Society of Glasgow, vol. xi, Supplement.) 8vo; pp. 134, with Index. (Glasgow, 1898.)

THAT this is an age of detail is well exemplified in the present memoir. The author records particulars of numerous sections of glacial drift in various parts of Ayrshire, and illustrates his observations by means of a sketch-map and fifty-two diagrams. The Geological Survey in Scotland has been singularly behindhand in publishing Drift Maps of the country, for, with the exception of some few six-inch maps where the Glacial gravels and Boulder-clay are represented by a vague kind of stippling, no representations of these Drifts have as yet been published. This is much to be regretted considering the scientific interest as well as the practical value attached to such maps; and the map now published by Mr. Smith fails to give any adequate idea of the distribution of the Drift. The author's observations lead him to conclude that the Ayrshire drift-beds comprise about eight divisions. In some sections he finds four Boulder-clays, and in all he notes the presence of marine fossils. Before beginning his critical examination he believed that the various Boulder-clays were 'ground-moraines'; eventually he came to the conclusion that they were deposited in water. That some of his Boulder-clays, such as he describes as pebbly clays, may have been deposited in water, is not likely to be questioned. In other

cases, where "the Boulder-clays appear occasionally to have been dragged, and in such cases the stones are more intensely striated and the shells scratched, the underlying rock being sometimes torn up and mixed with the bottom of the clay where the latter is thin," we should discern more direct evidence of land-ice than the author is willing to admit. He contents himself with the suggestion that after the deposition of the beds "they have evidently been subjected, in many localities, to considerable deformation, chiefly by the movement of land-ice." It is hardly necessary to point out that the occurrence of Foraminifera is no test of the marine origin of the deposits as they now occur, any more than would be the occurrence of *Gryphæa arcuata* or *Belemnites abbreviatus*. It is admitted that the great bulk of the marine shells occur as fragments, and that a few are scratched and polished; and they are recorded by the author as occurring in the Ayrshire drift-beds from a depth of 35 feet below, to an altitude of 1,061 feet above, sea-level. He does not specify the forms found at the different levels and localities, but, judging from his short general list, four species occur frequently, and a dozen or more occasionally in the Drifts. There are no indications from the mollusca of the varying depths of water during the time of the supposed marine submergence. Leaving the speculative portions of the author's memoir, we cannot doubt that the numerous facts recorded by him will be of service to local workers on the subject of glacial phenomena.

REVIEWS.

A Supposed Existing Ground-sloth in Patagonia.

(1) "Première Notice sur le *Neomylodon Listai*, un Représentant vivant des anciens Edentés Gravigrades fossiles de l'Argentina." Par Florentino Ameghino. La Plata, 1898. [Translated in *Natural Science*, vol. xiii, pp. 324–326 (Nov. 1898).]

(2) "On a Piece of Skin named *Neomylodon Listai*, from a Cavern near Consuelo Cove, Last Hope Inlet, Patagonia." By Dr. F. P. Moreno, C.M.Z.S. With a Description of the Specimen, by A. Smith Woodward, F.Z.S. Zool. Soc., Feb. 21st, 1899.

(3) "On some Remains of *Neomylodon Listai*, Ameghino, brought home by the Swedish Expedition to Tierra del Fuego, 1895–97." By Dr. Einar Lönnberg. Extract from *Svenska Exped. till Magellansländerna*, vol. ii, No. 7 (Stockholm, 1899).

LAST September Dr. Florentino Ameghino, the well-known palæontologist of La Plata, startled the scientific world by announcing the discovery of a still-existing ground-sloth, allied to *Mylodon*, in Patagonia. He had received some ossicles from a piece of apparently fresh skin found in Southern Patagonia, and he at once recognized them as essentially identical with the well-known dermal ossicles of *Mylodon* and *Glossotherium*. He mentioned that the skin itself had been found on the surface of the ground, without any trace of the skeleton; that the specimen was extremely tough, about 2 centimetres in thickness; and that it was completely

covered with coarse, hard, and stiff hair. He noticed that the small ossicles formed a dense armour in the lower layer of the skin below the hair. He concluded that the skin belonged to a mysterious quadruped which had been described to him some years before by the late Ramon Lista. He therefore named the animal *Neomylodon Listai*.

In January last Dr. F. P. Moreno, Director of the La Plata Museum, arrived in England with a remarkable piece of skin, about half a metre square, which he believed to be the identical specimen of which Dr. Ameghino had obtained some fragments. He exhibited the specimen to the Zoological Society on January 17th, expressing his opinion that it belonged to the extinct *Mylodon*. He further contributed a paper on this interesting discovery to the same Society on February 21st, while Mr. A. Smith Woodward added a detailed description and discussion of the specimen.

It appears that the piece of skin in question was observed by Dr. Moreno early last year hanging in a tree at a farm near Consuelo Cove, Last Hope Inlet, in Southern Patagonia. On making inquiries he found that the specimen had been dug up about two years previously from the floor of a cavern, at a height of, approximately, 200 metres above the sea. Dr. Moreno undertook further excavations at the spot, unfortunately without success; and then he forwarded the specimen by Government transport to the La Plata Museum to await his return.

At the meeting on January 17th much incredulity was expressed as to the antiquity of the specimen claimed for it by Dr. Moreno. In his completed paper, on February 21st, he therefore supported his contention by mentioning that he had found a well-preserved mummified human body in another cavern in the same district, and this certainly belonged to an extinct race of great antiquity, unknown even to the present Tehuelche Indians. Although the skin had a very fresh appearance and had evidently been stripped off the carcass by man, there was thus no difficulty in believing that it really dated back to the time of a fauna which no longer survived.

Mr. Woodward began his description of the specimen by remarking upon its freshness, and pointed to the abundant coating of dried serum on the old cut edges. If Dr. Moreno had not been able to give so circumstantial an account of the discovery, he would, indeed, have unhesitatingly pronounced the skin to belong to a Recent animal killed quite lately. At one corner of the specimen he thought he could recognize the base of the left ear, and thus concluded that the piece of skin probably belonged to the neck. In this case it would be quite large enough for *Mylodon*; but he noticed some slight differences in the minute structure of the dermal ossicles, which might imply that the specimen belonged to a distinct genus. Indeed, the piece of skin was observed to differ from the known dermal armour of *Mylodon*, and that of all other Edentata, in having the ossicles confined to the lower half of the dermis, while the covering of hair was implanted in every part of the upper half. The stiff hair most

closely resembled in structure that of the armadillos. Mr. Woodward had searched Lista's writings in vain for a reference to the mysterious quadruped mentioned by that traveller to Ameghino; but as this unknown animal was said to be only about as large as the Indian pangolin, it was evident that *Neomylodon Listai* could not be the creature in question.

Since the Zoological Society's meeting on February 21st, Dr. Einar Lönnberg's interesting description of the fragments of skin taken by Dr. Otto Nordenskjöld to Upsala, has reached England. Dr. Nordenskjöld's account of the discovery of the specimen agrees with that of Dr. Moreno; but the Swedish traveller was fortunately on the spot so early as April, 1896, and he was able to make an exploration of the cave soon after the skin was found. He dug up the sheath of a large Edentate claw, which Dr. Lönnberg rightly describes as almost certainly that of a ground-sloth; but he was unable to meet with any other traces of the animal. He only found some little balls of fur, not of *Neomylodon*, some fragments, probably of the huanaco (*Auchenia*), portions of human bones, and a piece of chipped stone. Dr. Lönnberg's description of the skin agrees closely with that of Mr. Woodward, but the former finds less difference between the microscopical structure of the ossicles in *Neomylodon* and *Mylodon* than is described by the latter. Dr. Lönnberg also supposes that the cuticle of the hair has been destroyed, while Mr. Woodward regards it as complete. Both agree, however, in considering the animal to have been of very large size; and Dr. Nordenskjöld believes that the largest piece of skin he saw in 1896 was at least 1·5 metres in length.

Whether the piece of skin in question belongs to a recent or to an extinct animal, there are thus considerable difficulties in solving the problems it suggests. If it does belong to *Mylodon*, as Dr. Moreno maintains, it implies either that this genus survived in Patagonia to a comparatively recent date, or that the circumstances of preservation were unique in the cavern where the specimen was discovered. On the other hand, if it belongs to a distinct and existing genus, as Dr. Ameghino maintains, and as most of the characters of the specimen itself would at first sight suggest, it is indeed strange that so large and remarkable a quadruped should have hitherto escaped detection in a country which has been so frequently visited by scientific explorers.

REPORTS AND PROCEEDINGS.

Geological Society of London.

I.—February 22, 1899.—W. Whitaker, B.A., F.R.S., President, in the Chair. The following communications were read:—

1. "On Varieties of Serpentine and Associated Rocks in Anglesey." By Professor T. G. Bonney, D.Sc., LL.D., V.P.R.S., F.G.S., and Miss C. A. Raisin, D.Sc.

The paper adds certain details to the description published in

1881 by Professor Bonney, and notices some important outcrops near Llyn Dinam and Llyn Penrhyn.

In the serpentine, enstatite frequently, and diallage sometimes, are present; these crystals being occasionally lustre-mottled. The most remarkable variety (which occurs distinctly at seven localities, although generally over a surface of only a few square feet) is that termed 'variolitic serpentine.' On a weathered surface knobs project as upon a variolitic diabase; these, under the microscope, are found to consist mainly of fibrous aggregates, probably actinolitic, sometimes exhibiting a radial structure, but rarely a concentric one. A carbonate is also present in variable amounts. The authors think that probably the original magma of this rock was differentiated, one part representing a pyroxenic constituent and becoming modified by alteration into the spherules; the other (olivine) producing ordinary serpentine.

Intrusive in the serpentine are diallage-rock, enstatite-rock, and rocks composed of both these minerals, all usually containing some serpentine. Various actinolitic rocks, often truly 'actinolitic schists,' probably have been derived through crushing from a diallage-rock (or one allied to it). Other intrusive rocks are the gabbro, which forms large important masses, a dyke of enstatite-gabbro, a porphyrite (?), and some greenstones.

A secondary development of tufted actinolite (compared by the authors with the actinolite in true schists, and with that in the Bastogne rock) is described from at least four localities. It is probably an indirect result of crushing in rocks which, though petrographically different, all originally contained a pyroxenic mineral which has been reconstituted.

Further details are given of the talc-schist and the chlorite-schist in this district, confirming the views that the former rock is a modification of a serpentine, and that the latter was originally intrusive.

The age of these igneous rocks cannot be determined; but they must be earlier than the great earth-movements to which the pressure-structures are due.

2. "Remarks on the Genera *Ectomaria*, Koken, and *Hormotoma*, Salter; with Descriptions of the British Species." By Miss Jane Donald. (Communicated by J. G. Goodchild, Esq., F.G.S.)

This paper deals with some of the genera into which the family of the Murchisoniidæ has been divided, and confines itself to the established genus *Hormotoma*, Salter, and the new genus *Ectomaria*, Koken, which contain some of the oldest known species of elongated Gasteropoda. Both forms are distinguished from the typical *Murchisoniæ* by merely possessing a sinus in the outer lip, instead of having a deep narrow slit with parallel edges; the lines of growth also retreat towards, and advance from, the sinus more obliquely. The author prefers to separate the elongated shells from the shorter Pleurotomariidæ, as Koken does, and to let the former constitute the family Murchisoniidæ.

The genera are described with two new species of *Ectomaria* and two new varieties of *Ectomaria pagoda*, Salt. Six new species of *Hormotoma* are also described, together with the species *H. Salteri*,

Ulrich & Schofield, *H.? gracillima*, Salt., *H. cingulata*, His., and *H. articulata*, Sow. The species of *Ectomaria* are all derived from the Cambrian and Ordovician rocks of Scotland, and the species of *Hormotoma* from various beds, ranging from the Durness Limestone to the Upper Ludlow rocks. An account of the distribution of the genera over Europe and America is also given.

II.—March 8, 1899.—W. Whitaker, B.A., F.R.S., President, in the Chair. The following communications were read:—

1. "An Analysis of the Genus *Micraster*, as determined by rigid Zonal Collecting, from the Zone of *Rhynchonella Cuvieri* to that of *Micraster cor-anguinum*." By Dr. A. W. Rowe, F.G.S.

The author has endeavoured to show, by means of rigid zonal collecting on a large scale, from the White Chalk of the Southern and South-Eastern coast-sections of England, that the genus *Micraster* is one and the same form gradually evolving from the more simple to the more complex. In doing this, he also contends that the genus may be divided into definite groups, each or several of which are absolutely diagnostic of the various Chalk zones, as defined by Barrois. The conclusions arrived at point to the regular and continuous deposition of the White Chalk, and strikingly confirm the general accuracy of Barrois's zoning.

The paper gives a minute comparison and description of the genus *Micraster* from a general point of view, and from that of a group, and deals particularly with the essential details of the test of the especial groups characteristic of each zone. The author claims that, so far as *Micraster* is concerned, each zone is marked by a definite facies of essential characters of the test, which are purely horizonal, and that all species and varieties, however divergent they may apparently be, occurring at any given horizon, are stamped with the impress of these marked horizonal features.

The author proves that, while in an isolated instance one may be unable to decide the horizon in the White Chalk whence a specimen of *Micraster* was derived, in the ninety-nine other cases the diagnostic features described by him point unerringly to the exact horizon, and thus afford a valuable aid to stratigraphical geology, especially as the essential zonal features of the test are easily made out in the field.

The author discusses the four groups into which the species of *Micraster* in these zones may be placed, and describes in detail the species in these groups.

The paper was illustrated by photographs, micro-photographs, and lantern-slides.

2. "On a Sill and Faulted Inlier in Tideswell Dale (Derbyshire)." By H. H. Arnold-Bemrose, Esq., M.A., F.G.S.

The compact dolerite in the marble quarry in Tideswell Dale has been generally described as a lava; but Sir A. Geikie, in his 'Ancient Volcanoes of Great Britain," suggested the possibility that it might be a sill. In the present paper the author endeavours to prove that the rock is really a sill. The compact dolerite rests

directly on marmorized Carboniferous Limestone in part of the quarry; elsewhere it is separated from it by vesicular 'toadstone' or by a bed of clay which is indurated and rendered columnar for a considerable depth. Above the dolerite comes another vesicular 'toadstone.' Thus the dolerite does not always rest on rocks of the same horizon; while the amount of alteration effected by it is far greater than is usually associated with lava-flows. Taking one bed in the limestone as a datum, the author establishes the following conclusions:—The dolerite does not cut across the beds of limestone; the clay varies in thickness, and is sometimes absent; the clay is rendered columnar and the limestone marmorized to a considerable depth, unless vesicular 'toadstone' of sufficient thickness intervenes, when the 'toadstone' itself is indurated; the base of the compact dolerite is approximately parallel to that of the metamorphosed rock. The dolerite itself is ophitic at its centre, granular above and below, and fine-grained at its margin; it is different in microscopic aspect from the vesicular 'toadstone.' Descriptions of the limestone and marble, the lavas, tuffs, and clay, are also given, and the positions of the faults bounding the inlier are defined.

CORRESPONDENCE.

THE AGE OF THE VALE OF CLWYD.

Sir,—In the article on this subject in your March issue, Mr. Strahan refers to a recent paper of mine on "The Carboniferous Limestone of the Vale of Clwyd,"[1] and to a difference of opinion between us as to the period during which the faulting of the strata occurred. He states that "We differ only on the theoretical question whether the faulting is in part pre-Triassic"; but it seems to me that we also differ as to whether the Trias anywhere overlaps the older rocks. In my paper it is stated that "I failed to find a satisfactory section showing the Trias overlapping any portion of the Carboniferous Limestone or the Purple Sandstone in the Vale of Clwyd," and I might have added, "or the Wenlock Shale."

Mr. Strahan gives several instances where he supposes the Trias to overlap the Limestone, but particularly along the east of the ridge on the west of Llanfair, Dyffryn Clwyd, and refers to "the Trias creeping across the edges of zone after zone of the limestone, until near Ruthin half that formation has been overlapped." In that locality I could not find any evidence of overlap, but that it was the gradually increasing denudation of the Limestone from south to north that caused it to become several hundred feet thinner. Of other examples he gives Bodfari, about which he remarks that "The evidence, however, is more suggestive than conclusive," and he qualifies his references in like manner as to other places. I have searched in vain for some evidence of an overlap by the Trias, but could not find any.

Mr. Strahan, in support of the pre-Triassic faulting, seems to rely on the N.N.W. faults so general along the west of the British Isles,

[1] Proc. Liverpool Geol. Soc., vol. viii (1897–8), p. 32.

and refers to the Vale of Eden, South Wales, and other distant areas in connection with the Vale of Clwyd. In my paper, however, I relied on the same system of faulting in South-West Lancashire and West Cheshire—about Liverpool and Birkenhead—where there are many such north-and-south faults, dislocating the Trias, and varying from a throw of a few up to 1,000 and even 2,000 feet,[1] equal to any in the Vale of Clwyd and all indisputably of post-Triassic age. This area is only 25 miles from the Vale, so that the conclusion is irresistible that the faults in both areas were produced at the same time. The post-Triassic faults in South-West Lancashire and West Cheshire are as great dislocations as those which traverse the Coal-measures in the country to the east, the only difference being that the Trias has been denuded from off the older strata, after the faulting had been completed.

With the exception of the Carboniferous Limestone, there are few really important exposures in the Vale of Clwyd, and most of them afford considerable scope for the use of the imagination, and it is surprising when anyone has a theory to uphold how facts crop up to support it. I have my theory, and appear to see faults where Mr. Strahan does not, while he thinks he can see evidences of the Trias overlapping the Carboniferous Limestone and perhaps the Wenlock Shale where I do not. It seems to me that it is the absence of good sections that is the cause of the difficulty.

I have been indebted to Mr. Strahan for much information, and for the position of exposures which, however, I always examined for myself, while on the other hand I constantly informed him of the progress of my work in many areas in North Wales. No geologist is a more careful observer than Mr. Strahan, and I much regret that he left the Vale of Clwyd before I began to examine it about seven years ago. Still, he has only completed a portion of it, so that when he has finished there may be little difference of opinion between us.

G. H. Morton.

Liverpool, *March* 20, 1899.

THE EASTERN MARGIN OF THE NORTH ATLANTIC BASIN.

Sir,—Will you allow me briefly to reply to the communications from Admiral Sir William Wharton and Mr. Hudleston which appear in the April number of the Geological Magazine, so far as they concern myself.

Presuming from the context that the question to which Admiral Wharton was invited to reply refers to some supposed statement of mine, I have to say that I am not aware of ever having asserted that there are "submarine vertical precipices 7,000 feet or so in height," and, therefore, as far as regards anything I have written I might leave the matter to others. But I can scarcely conceal from myself that the words have been put into my mouth, and I have reason to complain that no reference is given to which I can refer. I have, it is true, called the sub-oceanic 'slope,' along which the Continental

[1] The boundary fault (2,000 feet) has the Trias only on the downthrow side, but before the country was denuded the Triassic strata were on both sides.

platform terminates, 'an escarpment' or 'declivity' of 7,000 feet or more, but that is a very different thing from a 'vertical precipice' of that height. The nearest approach to the above quotation I can find in what I have written is in my paper published in the Transactions of the Victorian Institute for 1896–7, and subsequently in the GEOLOGICAL MAGAZINE, August, 1898, in which I state, and state truly, if the soundings are correct, that the escarpment off the Porcupine Bank of 7,800 feet "is quite precipitous" (p. 354); also that there is "a sheer precipice of 5,000 feet just south of La Rochelle Bank"; but in neither case do I use the word 'vertical,' although, in *some parts* of their descent, the cliffs no doubt *are* vertical. I draw a distinction between a 'precipice' and a 'vertical precipice.' It is very rarely that precipices of a thousand feet and upwards are vertical; but they do not cease to be precipitous at any angle less than (say) about 45° to 50° from the vertical. That some faces of the outer declivity approach these angles, or even exceed them, throughout a portion of their descent from the edge of the British-Continental platform, is fully borne out by the soundings, but it will be observed that this is a very different statement from that which has drawn forth the emphatic reply of the gallant Admiral.

But that there are precipices, in the sense I have explained above, of 6,000 or 7,000 feet in some of the submerged river valleys, such as those (presumably) of the Mondego (lat. 40° 30′ N.) and that which lies off Cave Carveiro (lat. 39° 30′ N.), is clearly shown by the soundings. I cannot expect Admiral Wharton to have recognized them; for even in tracing by a light dotted line the 100-fathom contour on the Admiralty Charts the draughtsman has sometimes lightly skipped across these indentations, which he probably considered of no consequence; still, there they are, when the isobaths are accurately worked out. I cannot, however, but feel obliged to Admiral Wharton for his quotation from the report of Captain Hoskyn when he says, regarding the form of the great declivity: "The intermediate soundings give no evidence [off the coast of Iceland] of a precipice, but a mountain of this height on the land would present an imposing appearance, with perhaps some steep escarpments." This is exactly my own view; and if the reader will examine the sub-oceanic sections given with the map in my original paper in the Transactions of the Victoria Institute, quoted above, he will see that this is so.

Referring now to Mr. Hudleston's important contribution in the March and April numbers of the GEOLOGICAL MAGAZINE, I have nothing to complain of the manner in which he has dealt with my own views; and I am glad that, once and for all, he has given his powerful aid in favour of the view that the British-Continental shelf was at a former time a land surface, and that "so long as Professor Hull confines himself to tracing the old river-courses cut in the continental shelf he is pretty safe" (p. 153). It then only remains to be determined to what depth below the general level of the platform the channels may be carried down;

and without drawing in the least on that "scientific imagination" with which my distinguished friend is kind enough to credit me, and relying only on the use of my reasoning faculty, I maintain that they must be carried down to the lowest levels shown by the soundings, since rivers only flow at the bottom of their valleys! And, in this connection, let me ask Mr. Hudleston with reference to his plan of the Gulf of Gascony and his isobathic contours of 100 fathoms and 1,000 fathoms of the Fosse de Cap Breton (p. 151), why has he left the latter in so incomplete a state? The 1,000-fathom contour is broken in two just above the point where the narrow channel of 1,500 fathoms opens out on the abyssal floor, as will be seen by reference to the map itself. Surely with so many soundings there can have been no great difficulty in carrying the 1,000-fathom line eastwards to the point of crossing, which would indicate the form of this remarkable sub-oceanic ravine; and if contours of intermediate depths (say 750, 500, and 250 fathoms) had been traced, they would have thrown additional light on its form and character. As it stands, Mr. Hudleston's map is unintelligible, and reminds me of that of M. Elisée Reclus, who leaves the mystery of the Fosse de Cap Breton unsolved.

EDWARD HULL.

April 7, 1899.

THE ASSOCIATION OF *SCHLŒNBACHIA INFLATA* WITH *HOPLITES INTERRUPTUS*.

SIR,—In discussing "The Base of the Gault in Eastern England" (GEOLOGICAL MAGAZINE, April, p. 161), Mr. A. M. Davies refers to the mixture of Lower and Upper Gault species at Heath, near Leighton Buzzard, and remarks that the same mixture "appears to exist in the Isle of Wight, where *S. inflata* occurs in the Gault Clay along with *H. interruptus*," his authority for this statement being the Geological Survey Memoir on the Isle of Wight.

It is true that in the tabular list of fossils at the end of that Memoir (p. 279) *Am. rostratus* and *Am. interruptus* are entered in the Gault column with the indication that both were found at Compton Bay, but it is not stated in the text that they were found in association. It so happens that I have had occasion to investigate this very point, and discovered that Mr. Rhodes had only found *H. interruptus* in the lower 20 feet of Gault, that a specimen obtained between 73 and 93 feet from the base was *H. denarius*, and that the *S. rostrata* came from a still higher bed, namely, that given at 8 feet thick in Mr. Strahan's section on p. 63 of the Memoir.

Other specimens of *H. interruptus* have been found in other parts of the island, but always in the lowest part of the Gault and never in association with *S. rostrata*. There is no mixture of zonal species, but the upper part of what is referred to 'Gault' by Mr. Strahan and others belongs to the zone of *S. rostrata*.

At Heath, on the other hand, there is unquestionably a commingling of Lower and Upper Gault species, and I am quite unable to explain it unless the Upper Gault should turn out to be much

thicker in that district than has hitherto been supposed. It must be remembered that the fossils are phosphatic, and the section exposed when I was there in 1884 showed that they lay in a seam of phosphatic nodules; hence some of them may have been derived from a lower horizon, but the occurrence of *S. rostrata* and *S. varicosa* within 20 feet of the base of the Gault remains to be explained.

A. J. Jukes-Browne.

Torquay, *April* 10, 1899.

OBITUARY.

JAMES DIGUES LA TOUCHE, B.A.

Born April 7, 1824. Died February 24, 1899.

Some five and forty years ago the Rev. James Digues La Touche of Stokesay, with Humphrey Salwey and Robert Lightbody of Ludlow, formed a trio of ardent students of the geology of South Shropshire. Surviving his fellow-workers for more than twenty years, the late Vicar of Stokesay is the best known to the present generation of geologists, and moreover, while all were equally willing to impart to others their intimate knowledge of the geology of their neighbourhood, he did not share his friends' reluctance to commit to writing the information which they acquired.

In his earlier geological papers he attacked two problems of considerable difficulty, one being the changes which sedimentary rocks undergo after their deposition and consolidation, and the other the amount of sediment brought down by rivers as a measure of the extent of denudation of the land. While we may not fully accept his original views on the "Mode of Formation of Limestone Bands" (Geologist, 1863), it is probable that "Nodules in the Limestone of Wenlock Edge" (Brit. Assoc. Rep., 1865) and "Spheroidal Structure in Silurian Rocks" (Journ. Geol. Soc. Ireland, 1871) have been formed in the way which he suggests, so that his first paper merely carries his theory a little too far. The difficulties encountered in the study of the "Alluvial Deposits of Rivers" (Trans. Woolhope Field Club, 1868) and the "Measurement of River-sediments" (Geol. Mag., 1868) are of quite another kind, being chiefly manipulative, and it seems a pity that the very careful and well thought-out experiments which he made to form an "Estimate of the Quantity of Sedimentary Deposit in the Onny" (Brit. Assoc. Rep., 1869) should have terminated with his "Report on the Sedimentary Deposits of the River Onny" presented to the British Association in 1870, and published as one of the "Reports on the State of Science" in the volume for that year. His papers in the Transactions of the Woolhope Field Club on the "Geology of the District around the Titterstone Clee Hill" (1868) and on the "Geology of the Longmynd Hills" (1870) should be read by all who wish to study these interesting districts.

His principal work, however, is "A Handbook of the Geology of Shropshire," published in 1884 (4to, London and Shrewsbury).

Commencing with a succinct but not very full account of the geological formations, from Pre-Cambrian to Lias, which are represented in the county of Salop, a few pages are very usefully devoted to the description of a number of routes by which these formations may be seen and conveniently studied, the best localities for fossils being pointed out. The remainder and much the greater part of the work is palæontological, consisting of descriptions of fossils, first of the genera and then of the species, which are depicted on 22 plates. A few new species are described and figured.

In July, 1872, he conducted, with Prof. Morris and Mr. Lightbody, an excursion of the Geologists' Association to the neighbourhood of Ludlow and the Longmynds, which was highly successful.

Geology was not his only scientific study; it was but one of many. In 1875 he contributed a paper to the Meteorological Society (a result of a visit to Natal, where he went in 1874 to assist Bishop Colenso); he kept a rain-gauge and other meteorological instruments; and from the year 1876 the rainfall at Stokesay Vicarage has appeared annually in Symons' "British Rainfall." Through his astronomical work he became acquainted with Sir William Herschel, grandson of Herschel I. He studied microscopical petrology, making rock-sections with a machine of his own designing and examining them under the microscope until his eyesight became affected, when he turned his attention to the practical study of electricity, constructing the necessary apparatus himself. In Natural History his favourite studies were entomology and botany; he was expert in dissecting insects, and he made a complete collection of the plants of his neighbourhood. In his parish is the only British locality for *Astrantia major*, and he was proud to show this plant growing to those whom he could trust to look and not to take, but careful not to do so to the mere collector. It may be that his taste for botany and love of flowers were acquired from his intimate friend Sir Joseph Hooker. He had considerable archæological knowledge, as his "Guide to Stokesay Castle" attests, and at the time of his death he had just completed a history of his parish intended for publication.

With these diversified studies Mr. La Touche was also assiduous in parochial work. His ancestors on both sides being of Huguenot extraction, he appears to have inherited an intense desire, with the needful ability, to help those around him to acquire useful knowledge and to become expert artisans. He not only taught daily in his parish schools such subjects as Latin, French, mathematics, land-surveying, and shorthand, but he also had a room built which he fitted up with carpenter's bench, lathe, and a chemical laboratory, where he gave practical instruction in various useful arts, including bookbinding. His fame as a tutor was worldwide, and amongst his private pupils were sons of Bishop Colenso, of Professor Max Müller, and of Sir Joseph Hooker, and two nephews of Sir Charles Lyell.

As Vicar of Stokesay for the long period of 44 years, he had endeared himself to his parishioners, who will miss his commanding

but genial presence, his deep-toned but pleasant and cheery voice. He leaves a widow, three sons, and two daughters. His eldest son, who is in the Church, succeeds his father as Vicar of Stokesay; one is on the staff of the Geological Survey of India; and the other is a Civil Engineer in the Public Works Department of the Madras Presidency. J. H.

OTHNIEL CHARLES MARSH, LL.D. (YALE), PH.D. (HEIDELBERG).

BORN OCTOBER 29, 1831. DIED MARCH 18, 1899.

(WITH A PORTRAIT.)

SCIENCE of late has become so cosmopolitan in its interests that the loss of any one of its leading members is felt and mourned in distant lands as keenly as in the University in which he may have made his home.

A while since we had to regret the loss of Professor Dames of Berlin; yesterday we deplored that of Professor Nicholson of Aberdeen; to-day we mourn the loss of our dear American cousin, Professor O. C. Marsh of Yale. Such ties of sympathy and personal regard tend to knit more closely together our geological friends everywhere, and we join hands far and near in times of joy and sorrow.

O. C. Marsh was born at Lockport, New York, October 29, 1831, and graduated at Yale in 1860. Of his early years we have no details, but it may be inferred that it was due to the interest of his uncle, Mr. George Peabody, that after his schooldays had long ended he entered Yale College, where he graduated in 1860 at the age of 29. After travelling in Canada and Nova Scotia, where he discovered remains of a new Enaliosaurian (*Eosaurus Acadianus*) in the Coal-formation of Nova Scotia, he came to Europe and spent three years in the Universities of Berlin, Heidelberg, and Breslau, under Beyrich, Ehrenberg, Roemer, and other famous German Professors.

He visited London in 1864, and whilst diligently studying in the British Museum he became acquainted with the writer, and from that time a warm friendship was commenced, which lasted to the end. A letter arrived on the morning of the 20th March, addressed in Marsh's well-known handwriting, and also a telegram, the former full of life and pleasant hopes and promises, the latter the messenger of death: "Professor Marsh died yesterday, illness short, Beecher." Reverting again to 1864: we had just before (1862) secured the famous collection of Dr. Haberlein from the lithographic-stone quarries of Eichstatt, in Bavaria, which, among other treasures, contained the famous *Archæopteryx*. Marsh at that time devoted himself diligently to the investigation of the fossil Annelides, and discovered on one specimen the well-preserved jaws of *Helminthodes antiquus*, which he carefully worked out with his own hands and afterwards described and figured.

Returning to America in 1866, he joined Professor Sir William Thomson (now Lord Kelvin) when engaged in the delicate task of picking up and splicing the first Anglo-American cable in mid-Atlantic. The same year he was offered the Chair of Palæontology

at Yale University, the Professorship being instituted for him, and there he remained until the close of his career. Within two years after his appointment Marsh ceased to write miscellaneous papers, and devoted all his time, energies, and resources to the pursuit of Vertebrate Palæontology.

Aided by the liberality of his uncle, Mr. George Peabody, the founder of the Peabody Museum of the Yale University, Marsh commenced a series of expeditions for palæontological purposes to the Rocky Mountain region and the Far West. One of the earliest of these was in 1870, and lasted more than five months. It extended into Kansas, Nebraska, and Utah. The fossils obtained were chiefly from the "Loup River" Pliocene and the "Mauvaises Terres" or Miocene, both deposits having been accumulated beneath the waters of enormous fresh-water lakes, whose banks were tenanted by many of the peculiar Pachyderms of the Paris Basin. Many species of fossil horses (one of them allied to *Hipparion*), of Rhinoceroses, of *Titanotherium*, an *Elotherium*, camels, and carnivores were secured. These old lake-deposits of Miocene age abound in remains of crocodiles, serpents, turtles, and fishes. Numerous Mosasaurian remains also were obtained in Kansas. Another expedition followed in 1874 to the south of the Uintah Mountains, and was equally successful.

From the date of Professor Marsh's establishment at Yale University, a long succession of scientific papers appeared, mostly in Silliman's American Journal and in the Geological Magazine.

Of his earlier papers may be mentioned the following:—On the discovery of a diminutive species of fossil horse (*Equus parvulus*); Reptilian remains from Brazil; Mosasauroid reptiles from New Jersey; a gigantic fossil serpent (*Dinophis grandis*) from New Jersey; fossil birds from the Cretaceous and Tertiary; a fossil Gavial from New Jersey; a gigantic species of Pterodactyle; new Tertiary mammals and birds; on *Hesperornis regalis*, a toothed bird; notes on *Tinoceras*; fossil quadrumana and carnivora from Wyoming; a new species of *Ichthyornis*; fossil mammals of the order Dinocerata; on the genus *Tinoceras*, etc.; on the structure of the Brontotheriidæ; new equine mammals; on the small size of the brain in Tertiary mammals; on the Tillodontia; on the genus *Coryphodon*; on the Pterosauria; on the Stegosauria, a new order of extinct Reptilia; on the Sauranodonta and principal characters of American Jurassic Dinosaurs; on Dinosaurian reptiles from the Jurassic formation; new Jurassic mammals.

Professor Marsh's first great work appeared in 1880 on the *Odontornithes*, a monograph on the extinct toothed birds of North America (4to, pp. xv + 201, with 34 plates and 40 woodcuts). Certainly, as a scientific publication, it surpasses any which have already appeared devoted to palæontology.

In the same geological horizon with the *Odontornithes*, Professor Marsh discovered and described *the first Pterodactyles*, or flying-lizards of America. These are of enormous size, having a spread of wings of nearly 25 feet, and were specially remarkable for having no teeth, hence resembling our modern birds.

The bird-like Fossil Footprints of the Triassic sandstones from the Connecticut Valley always interested Marsh, and he keenly and critically studied them; as, although no bones had been found near them, they had been regarded as undoubted footprints of birds, because it was supposed that birds alone could make such series of bipedal, three-toed tracks, and leave no impression of a tail. Marsh was able in later years to show that these bird-like tracks were most probably made by a small bipedal reptile named *Anchisaurus*, an early Triassic dinosaur.

In 1884 appeared the second of Marsh's great works, a Monograph on the extinct Dinocerata, a gigantic order of Ungulate mammals (Washington, 4to, pp. xviii and 237, with 56 plates and 200 woodcuts). These huge beasts, which nearly equalled the elephant in size, roamed in great numbers about the borders of the ancient Eocene lake-basin in Wyoming, where so many of them were afterwards entombed. The drainage of this lake by the Green River, its elevation from six to eight thousand feet, and subsequent erosion by the Colorado, has left exposed by slow denudation the great "*mauvaises terres*," or "bad lands," carved into peaks, cliffs, and columns of the most fantastic and varied shapes and colours, and has exposed the remains of the many extinct animals and the bones of the great Dinocerata for the attention of the explorer. More than 200 individuals of the Dinocerata have been brought together in Yale College Museum alone.

A *papier-maché* model, taken from the actual bones of the complete skeleton of *Tinoceras ingens*, has been presented by Professor Marsh to the Geological Department of the British Museum (Natural History), London, and serves as an interesting memorial of his work.

Professor Marsh's third Monograph is on the Dinosaurs of North America, and appeared in 1896 (imperial 8vo, pp. 110, with 84 plates). No fewer than fourteen papers, richly illustrated, had already appeared on this subject in the GEOLOGICAL MAGAZINE from 1882 to 1896, so that this Monograph could not be expected to add much to the knowledge already derived from the author's numerous separate memoirs. But all Marsh's work on the Dinosauria is here brought into one focus. Many fine plates were held back by him, as well as many details, for a future *édition de luxe*, which, alas! he never lived to produce, but which will doubtless be published at an early date by the University of Yale, provision having been made for that purpose by Professor Marsh in his will.

An excellent summary of Marsh's observations on Dinosaurs will be found in the GEOLOGICAL MAGAZINE, 1896 (pp. 388–400), with twelve admirable restorations of the leading forms. (See also GEOL. MAG., 1897, pp. 38–44.)

Marsh's toothed birds and toothless Pterodactyles may seem to be two of the most remarkable of his numerous discoveries; but his Monograph on the Dinocerata is in itself a grand and classical piece of work, sufficient alone to merit the highest distinction.

Yet if we turn to his long researches upon the Dinosauria, one would feel certainly disposed to give to these the first place of

importance in his lifework. Such wonderful forms of terrestrial reptiles as he has discovered, e.g., *Brontosaurus*, *Stegosaurus*, *Triceratops*, *Claosaurus*, *Anchisaurus*, *Ceratosaurus*, *Diplodocus*, and many others, either by their size or peculiar characters, have produced a more powerful impression on the public mind than almost any of the other discoveries of modern science.

From 1868 to 1890 scientific expeditions were organized to explore and collect fossils in the Rocky Mountain districts, resulting in the bringing to Yale of more than a thousand species of vertebrata; more than 400 of which have been described by Professor Marsh. He is said to have crossed the Rocky Mountains thirty times on these expeditions, and, although he may not have crossed the Atlantic quite so often, he was a very frequent visitor to England and the Continent, and his relations with men of science here were of the friendliest kind: witness the award to him of the first Bigsby Medal in 1877 by the Council of the Geological Society, who also elected him a Foreign Member in 1898.

Of the struggles for priority and other personal scientific squabbles which embittered some years of his life we need not now speak; over the silent grave we may only remember with gratitude the vast services to science which Marsh lived to perform.

By his will he leaves his entire estate to Yale University, with the exception of 10,000 dollars to the National Academy of Sciences, to promote original scientific research. Even his home and residence are left to the Yale University, to be used as a Botanic Garden and Laboratory. He is estimated to have expended 250,000 dollars on collecting the fossils which he gave to the Yale Museum a year ago. His estate will probably realize 100,000 dollars. (It should be also mentioned that during the thirty-three years in which Professor Marsh held the Chair of Palæontology in Yale, he received no salary for his services.)

A sum of 30,000 dollars is left to the Trustees of the Peabody Museum, to pay for the preparation and publishing of the results of his explorations. In this case we may *reverse* the *verdict* of Shakespeare and say,

"The *good* men do lives after them."

I cannot help quoting a few words from Marsh's last letter, dated Yale, March 10th, 1899:—"I did not intend to distribute many of these [casts] until after my monographs were published, but considering what confusion there seems to be in your country on the subject [of the Dinosauria], good casts of the characteristic American specimens might help on the missionary work of scientific instruction, and thus aid in bringing still nearer together our two countries."

It seems sad that he, who was with us at the August meeting of the International Zoological Congress at Cambridge, and the subsequent meeting of the British Association at Bristol, in September, reading and discussing papers there, should now have passed over to the great majority and that we should see his face no more. H. W.